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NEET | JEE

ESSENTIALS

Class
XI

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Unit 5

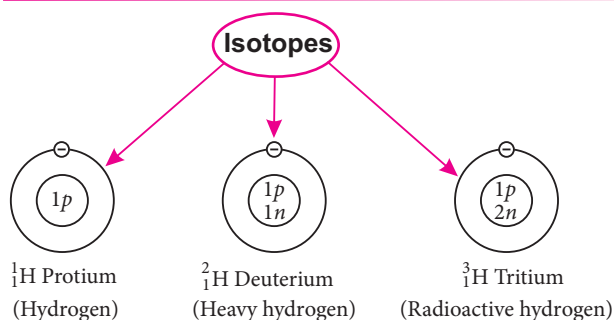
Hydrogen | The s-Block Elements

HYDROGEN

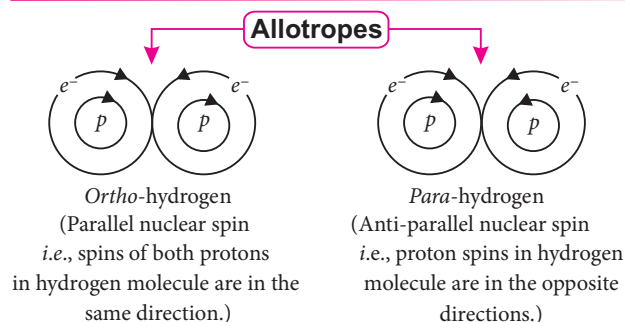
POSITION OF HYDROGEN IN THE PERIODIC TABLE

- ✚ $H_1^{1.008}$: Electronic configuration $-1s^1$
- ✚ Hydrogen is the first element of the periodic table and its position is anomalous.
- ✚ It resembles alkali metals w.r.t. electronic configuration, electropositive character, valency, oxidation state, combination with electronegative elements and liberation at cathode.
- ✚ It resembles halogens w.r.t. electronic configuration (one electron less than the nearest noble gas configuration), ionisation energy, electronegative character, oxidation state, diatomic nature and liberation at anode.
- ✚ It does not have metallic characteristics at ordinary temperature and pressure but under very high pressure, it is expected to behave like a metal.
- ✚ H^+ has very small size ($\sim 1.5 \times 10^{-3}$ pm) as compared to normal atomic and ionic sizes of 50 to 220 pm. It cannot exist freely and is always associated with other atoms or molecules.

ISOTOPES



ALLOTROPES



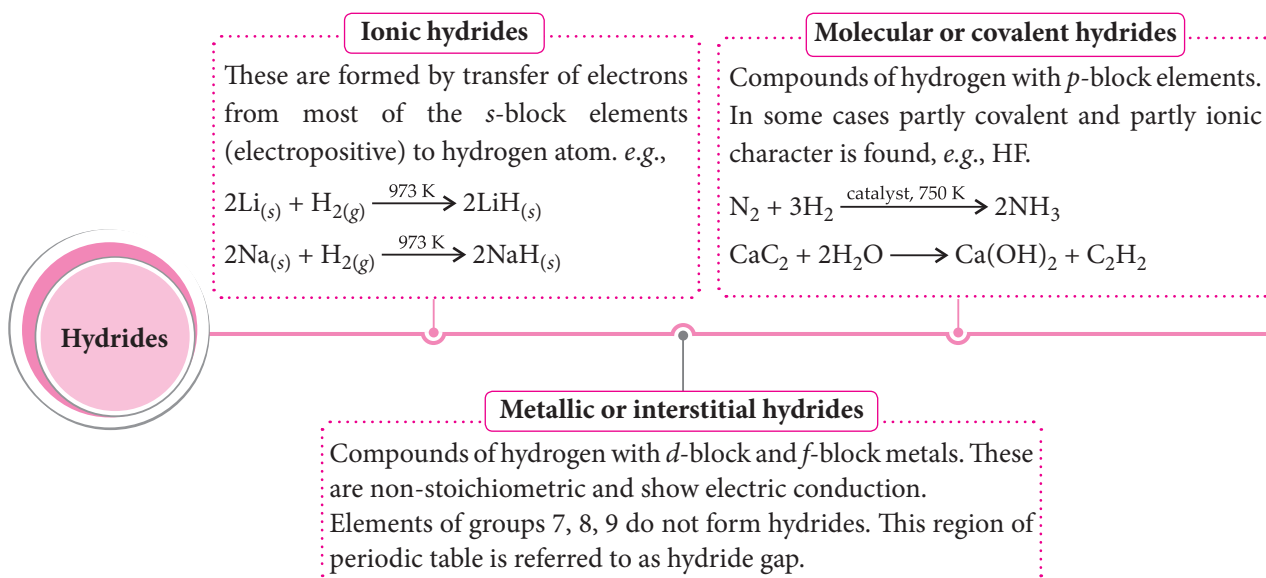
PREPARATION AND PROPERTIES OF HYDROGEN

| Preparation | Chemical Properties |
|---|--|
| $\text{Zn} + \text{H}_2\text{SO}_4 (\text{dil.}) \xrightarrow[\text{-ZnSO}_4]{\text{Lab method}} \text{H}_2$ | $\xrightarrow[\text{700}^\circ\text{C}]{+ 2\text{Li}} 2\text{Li}^+\text{H}^-$ <p>Lithium hydride</p> |
| $2\text{H}_2\text{O} \xrightarrow[\text{Electrolysis, -O}_2]{\text{H}_2\text{SO}_4} \text{H}_2$ | $\xrightarrow[\text{Reduction}]{+ \text{CuO}} \text{Cu} + \text{H}_2\text{O}$ |
| $2\text{Na}^+ + 2\text{Cl}^- + 2\text{H}_2\text{O} \xrightarrow[\text{Electrolysis of brine}]{-2\text{Na}^+, -\text{OH}^-, -\text{Cl}_2} \text{H}_2$ | $\xrightarrow[\text{Catalyst, 350}^\circ\text{C}]{+ \text{Br}_2} 2\text{HBr}_{(\text{g})}$ |
| $\text{C} + \text{H}_2\text{O}_{(\text{steam})} \xrightarrow{\text{[Bosch's process]}} \text{CO} + \text{H}_2$ <p>Water gas</p> | $\xrightarrow[\text{[Haber's process]}]{+ \text{N}_2, \text{Fe catalyst}} 2\text{NH}_3$ |
| $\xrightarrow[\text{500}^\circ\text{C}]{+ \text{H}_2\text{O}_{(\text{steam})}, \text{Fe}_2\text{O}_3 + \text{Cr}_2\text{O}_3 (\text{catalyst})} \text{H}_2$ <p>- CO₂</p> | $\xrightarrow[\text{[Fischer-Tropsch Synthesis]}]{+ \text{CO; Fe, Co, Mo}} \text{Mixture of hydrocarbons}$ |
| $2\text{Fe} + 4\text{H}_2\text{O}_{(\text{steam})} \xrightarrow[\text{[Lane's process]}]{773 \text{ K} - 1050 \text{ K}} \text{H}_2$ | $\xrightarrow[\text{700 K}]{+ \text{CO; Cu, ZnO/Cr}_2\text{O}_3 (\text{catalyst})} \text{CH}_3\text{OH}$ <p>Methanol</p> |
| | $\xrightarrow[\text{Electric discharge}]{+ \text{O}_2, 970 \text{ K}} 2\text{H}_2\text{O}$ |
| | $\xrightarrow[\text{Hydrogenation, 473 K}]{+ \text{CH}_2=\text{CH}_2, \text{Ni / Pt}} \text{CH}_3-\text{CH}_3$ <p>Ethane</p> |

HYDRIDES

☞ Dihydrogen, under certain reaction conditions, combines with almost all elements except noble gases to form binary compounds called *hydrides*. If 'E' is the symbol of an element, then hydride can be expressed as EH_x (e.g., MgH_2) or E_mH_n (e.g., B_2H_6).

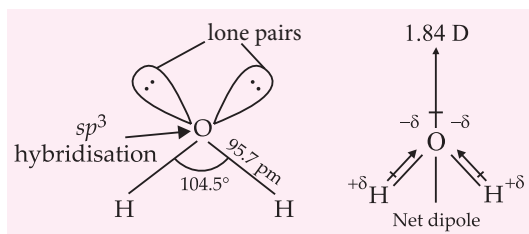
CLASSIFICATION OF HYDRIDES



WATER

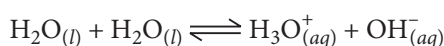
Water is the principal constituent of earth's surface.

Structure :

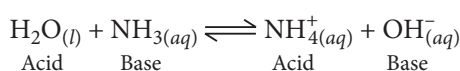
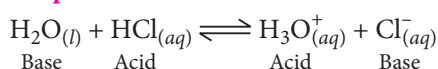


CHEMICAL PROPERTIES OF WATER

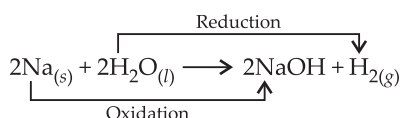
Self-ionisation of water :



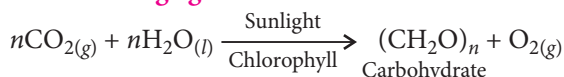
Amphoteric character :



As an oxidising agent :



As a reducing agent :



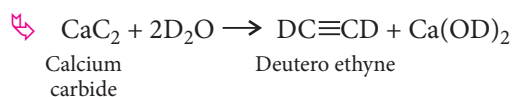
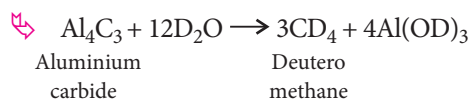
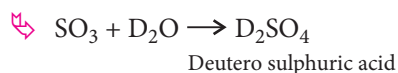
HEAVY WATER (D₂O)

Discovered by Urey.

It is obtained from ordinary water by prolonged electrolysis.

It is colourless, odourless and tasteless liquid. In India, heavy water plants are located at Nangal, Rourkela, Trombay, Namrup, Neyveli and Naharkatiya.

CHEMICAL PROPERTIES OF HEAVY WATER



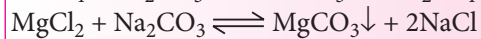
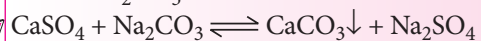
HARD AND SOFT WATER

Soft water : Water which forms lather with soap easily is called *soft water*.

Hard water : Water which does not form lather with soap easily and hence is unfit for washing is called *hard water*.

Types of Hard Water

Permanent hardness : It is due to the presence of soluble chlorides and sulphates of Ca and Mg. It can be removed by treating it with Na_2CO_3 .



Removal of permanent hardness is affected by ion exchangers like zeolite, permutit and synthetic resins, etc.

Temporary hardness : It is due to the presence of bicarbonates of Ca and Mg. It can be removed by

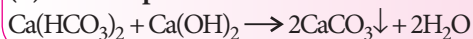
(a) Boiling :



Soluble bicarbonates Insoluble carbonates

Here, $M = \text{Mg}$ or Ca

(b) Clark's process :



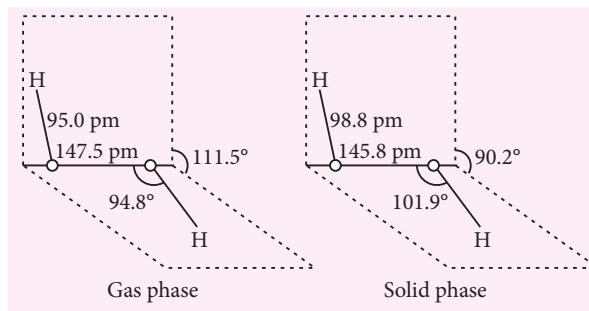
HYDROGEN PEROXIDE OR OXYGENATED WATER (H₂O₂)

It is the hydride of oxygen.

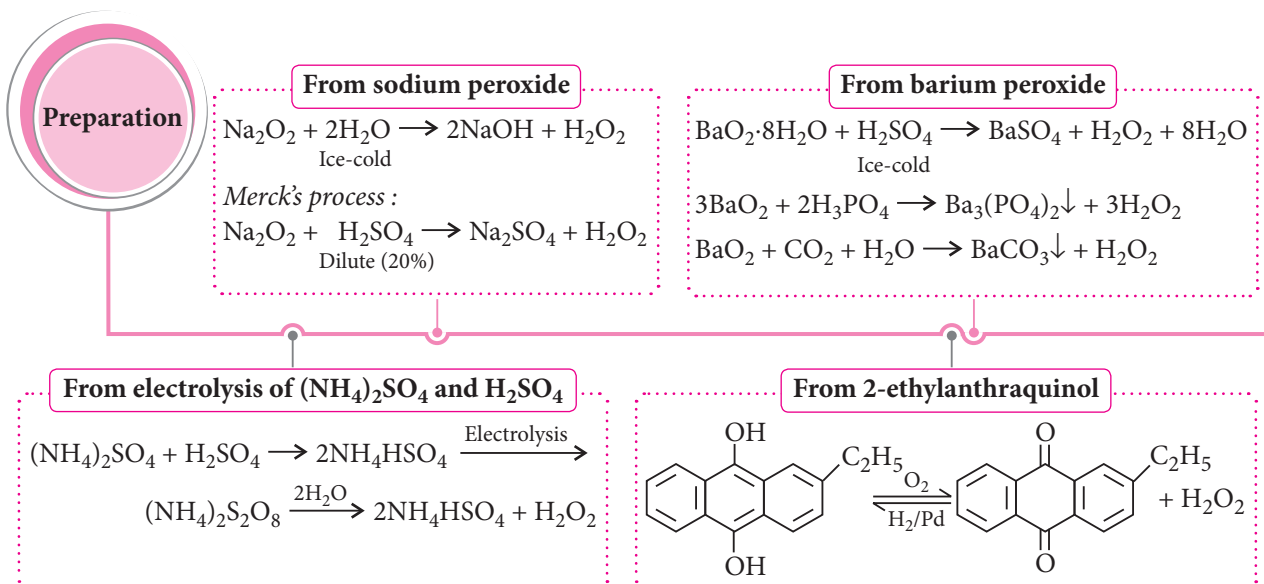
Its boiling point is higher than H_2O due to the presence of stronger intermolecular hydrogen bonding than in water.

Structure :

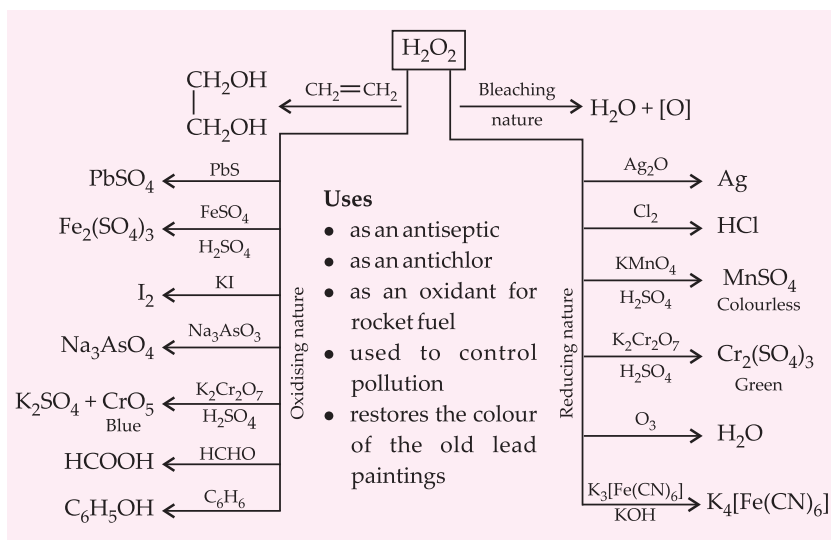
H_2O_2 has an open book like (non-planar) structure.



Preparation of H₂O₂



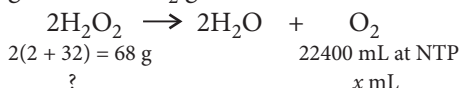
Reactions and uses



Concentration determination

➤ Concentration of H₂O₂ is expressed in terms of "volume of O₂".

"10 volume" of H₂O₂ means that 1 mL of H₂O₂ at NTP gives 10 mL O₂ gas.



22400 mL of O₂ at NTP are obtained from 68 g of H₂O₂.

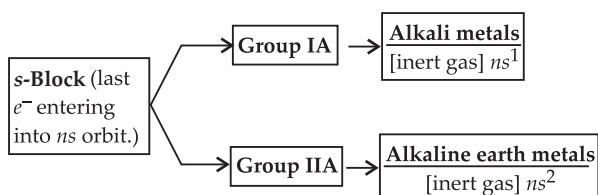
x mL of O₂ at NTP obtained from = $\frac{68}{22400} \times x$ g of H₂O₂

➤ $\text{Conc. in g/L} = \frac{68x}{22400} \times 1000 = \frac{680x}{224} \text{ g/L}$

➤ $\text{Normality (N)} = \frac{\text{conc. in g/L}}{\text{equiv. wt.}} = \frac{680x}{224} \times \frac{1}{17} = \frac{x}{5.6}$

➤ $\text{Molarity (M)} = \frac{\text{conc. in g/L}}{\text{mol. wt.}} = \frac{680x}{224} \times \frac{1}{34} = \frac{x}{11.2}$

THE s-BLOCK ELEMENTS



GROUP 1 ELEMENTS : ALKALI METALS

| Property | Li | Na | K | Rb | Cs |
|--------------------------|-------------|---------------|-------------|----------------|-------------|
| At. no. (Z) | 3 | 11 | 19 | 37 | 55 |
| Electronic configuration | [He] $2s^1$ | [Ne] $3s^1$ | [Ar] $4s^1$ | [Kr] $5s^1$ | [Xe] $6s^1$ |
| Flame colouration | Crimson red | Golden yellow | Pale violet | Reddish violet | Blue |

PHYSICAL PROPERTIES

Physical state : Alkali metals are silvery white, soft and light metals. They have only one valence electron, so the metallic bond is not so strong which makes them soft metals.

Hydration of ions : Degree of hydration of alkali metal ions decreases in the order : $Li^+ > Na^+ > K^+ > Rb^+ > Cs^+$.

Conductivity : Increases down the group due to the presence of loosely held valence electron which is free to move throughout the metal structure.

Electropositive or metallic character : Alkali metals are strongly electropositive because of their low ionisation energies. Hence, increases down the group.

Atomic and ionic radii : Increases down the group due to the presence of an extra shell of electrons.

$$Li < Na < K < Rb < Cs$$

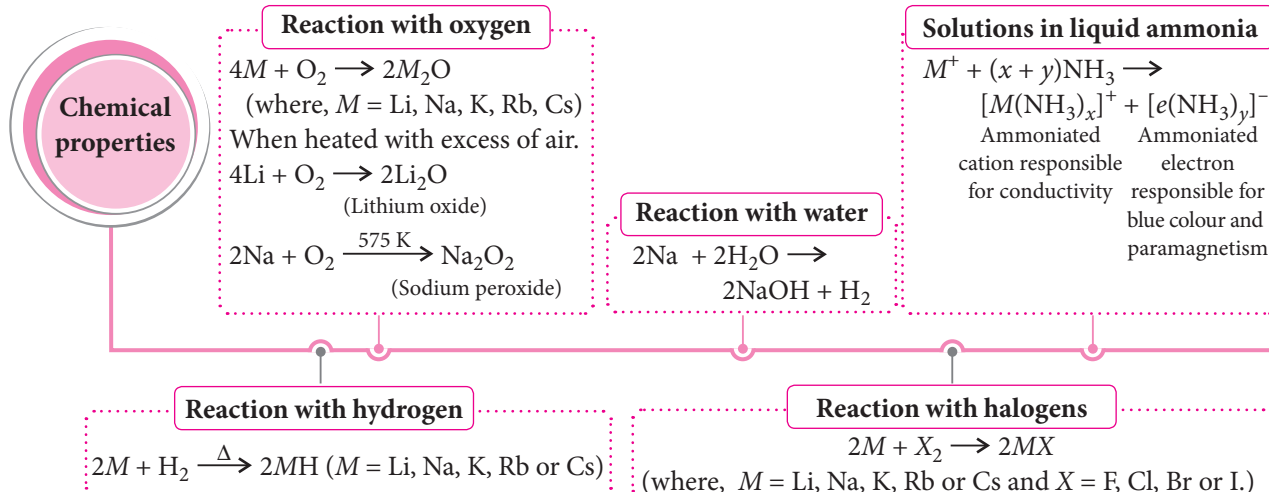
Density : Increase from Li to Cs. However, potassium is lighter than sodium (anomaly) probably due to an unusual increase in atomic size of potassium.

Melting and boiling points : Due to weak intermetallic bonding, alkali metals have very low m. pt. and b. pt.

Ionization energy : Decreases down the group due to increase in size.

Group 1 Elements
(ns^1)

CHEMICAL PROPERTIES



SOME IMPORTANT COMPOUNDS

| Compound | Preparation | Properties | |
|--|--|--|---|
| | | Physical | Chemical |
| Sodium hydroxide or caustic soda (NaOH) | Electrolytic process in mercury cathode cell $2\text{NaCl}_{(aq)} + 2\text{H}_2\text{O}_{(l)} \longrightarrow \underbrace{\text{H}_2(g)}_{\text{At cathode}} + \underbrace{\text{Cl}_2(g) + 2\text{NaOH}_{(aq)}}_{\text{At anode}}$ | NaOH is deliquescent, white crystalline solid. NaOH dissolves readily in water to yield highly alkaline solution which is corrosive, soapy in touch and bitter in taste. | $\begin{array}{l} \text{Na}_2\text{CO}_3 \xleftarrow{\text{CO}_2} \text{HCOONa} \xleftarrow{\text{CO}} \text{Na}_2\text{SO}_3 \xleftarrow{\text{SO}_2} \text{Na}_2\text{S}_2\text{O}_3 \xleftarrow{\text{S}, \Delta} \text{NaH}_2\text{PO}_2 \xleftarrow{\text{P}_4} \text{NaH}_2\text{PO}_2 + \text{PH}_3 \xleftarrow{M(M = \text{B, Al})} \text{NaMO}_2 \xleftarrow{X_2(\text{Hot})} \text{NaX} + \text{NaXO}_3 + \text{H}_2\text{O} \xleftarrow{\text{NH}_4\text{Cl}} \text{NH}_3 \uparrow + \text{NaCl} + \text{H}_2\text{O} \end{array}$ $\begin{array}{l} X_2(\text{Cold}) \rightarrow \text{NaX} + \text{NaXO} + \text{H}_2\text{O} \\ \text{Zn or ZnO}_2 \rightarrow \text{Na}_2\text{ZnO}_2 \\ \text{SiO}_2 \rightarrow \text{Na}_2\text{SiO}_3 \\ \text{Al}_2\text{O}_3 \text{ or } \text{Al(OH)}_3 \rightarrow \text{NaAlO}_2 \\ \text{Sn} \rightarrow \text{Na}_2\text{SnO}_3 \\ \text{ZnSO}_4 \rightarrow \text{Zn(OH)}_2 \xrightarrow{\text{NaOH}} \text{Na}_2\text{ZnO}_2 \\ \text{FeCl}_3 \rightarrow \text{Fe(OH)}_3 \downarrow + \text{NaCl} \end{array}$ |
| Sodium carbonate or washing soda ($\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O}$) | Sodium carbonate is manufactured by <i>Solvay process</i> . Sodium bicarbonate being sparingly soluble, crystallises out. This is finally calcined to form sodium carbonate. $\text{Na}^+ + \text{Cl}^- + \text{NH}_4^+ + \text{OH}^- + \text{CO}_2 \longrightarrow \text{Na}^+ + \text{HCO}_3^- + \text{NH}_4^+ + \text{Cl}^-$ $\text{Na}^+ + \text{HCO}_3^- \longrightarrow \text{NaHCO}_3 \text{ (as precipitate)}$ $2\text{NaHCO}_3 \xrightarrow{\Delta} \text{Na}_2\text{CO}_3 + \text{CO}_2 + \text{H}_2\text{O}$ | Sodium carbonate is a white crystalline solid which readily dissolves in water. Its solubility decreases with increase of temperature. | $\begin{array}{l} 2\text{NaHCO}_3 \xleftarrow{\text{CO}_2} \text{Na}_2\text{SiO}_3 \xleftarrow{\text{SiO}_2} \text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O} \xleftarrow{\text{H}_2\text{O}} 2\text{NaOH} + \text{H}_2\text{CO}_3 \\ \text{CaCO}_3 \xleftarrow{\text{Ca(OH)}_2} \text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O} \xleftarrow{\Delta} \text{Na}_2\text{CO}_3 + 10\text{H}_2\text{O} \end{array}$ $\begin{array}{l} \text{HCl} \rightarrow \text{NaCl} + \text{H}_2\text{O} \\ \text{SO}_2 \rightarrow \text{Na}_2\text{SO}_3 + \text{CO}_2 \\ \text{H}_2\text{O, S} \rightarrow \text{Na}_2\text{S}_2\text{O}_3 \end{array}$ |
| Sodium hydrogen carbonate or baking soda (NaHCO_3) | Obtained as an intermediate product in <i>Solvay process</i> . $\text{NaCl} + \text{NH}_3 + \text{CO}_2 + \text{H}_2\text{O} \longrightarrow \text{NaHCO}_3 + \text{NH}_4\text{Cl}$ It can also be prepared by passing CO_2 through solution of sodium carbonate. $\text{Na}_2\text{CO}_3 + \text{CO}_2 + \text{H}_2\text{O} \longrightarrow 2\text{NaHCO}_3$ | It is a white crystalline powder and less soluble than sodium carbonate. | $2\text{NaHCO}_3 \xrightarrow[100^\circ\text{C}]{\Delta} \text{Na}_2\text{CO}_3 + \text{H}_2\text{O} + \text{CO}_2$ <p>It is amphiprotic <i>i.e.</i>, it can act as H^+ donor as well as H^+ acceptor.</p> $\text{HCO}_3^- + \text{H}^+ \rightleftharpoons \text{H}_2\text{CO}_3;$ $\text{HCO}_3^- \rightleftharpoons \text{H}^+ + \text{CO}_3^{2-}$ |

GROUP 2 ELEMENTS : ALKALINE EARTH METALS

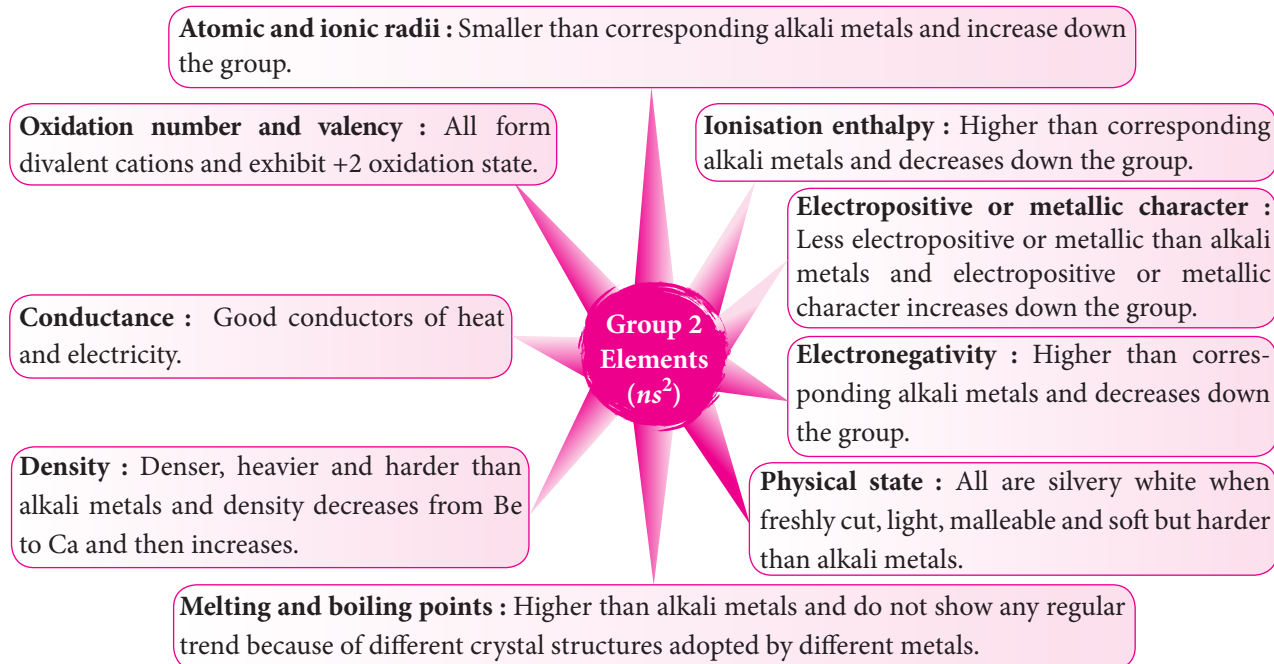
| Property | Be | Mg | Ca | Sr | Ba | Ra |
|--------------------------|-------------|-------------|-------------|-------------|--------------|-------------|
| At. no. (Z) | 4 | 12 | 20 | 38 | 56 | 88 |
| Electronic configuration | [He] $2s^2$ | [Ne] $3s^2$ | [Ar] $4s^2$ | [Kr] $5s^2$ | [Xe] $6s^2$ | [Rn] $7s^2$ |
| Flame colouration | None | None | Brick red | Crimson | Grassy green | Crimson |

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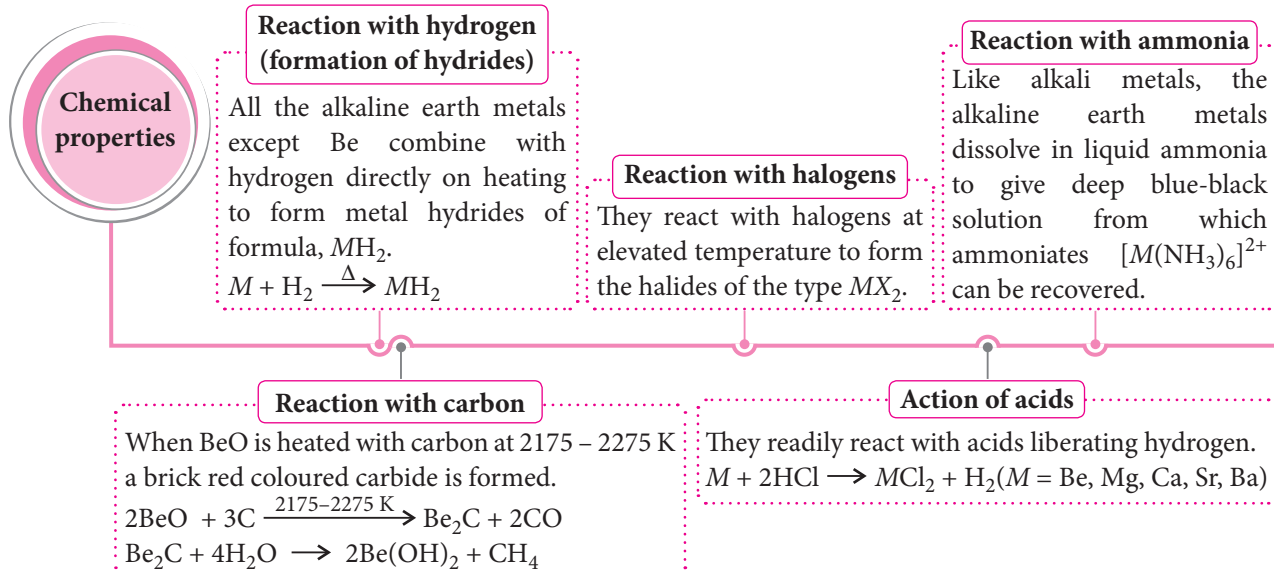
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PHYSICAL PROPERTIES



CHEMICAL PROPERTIES



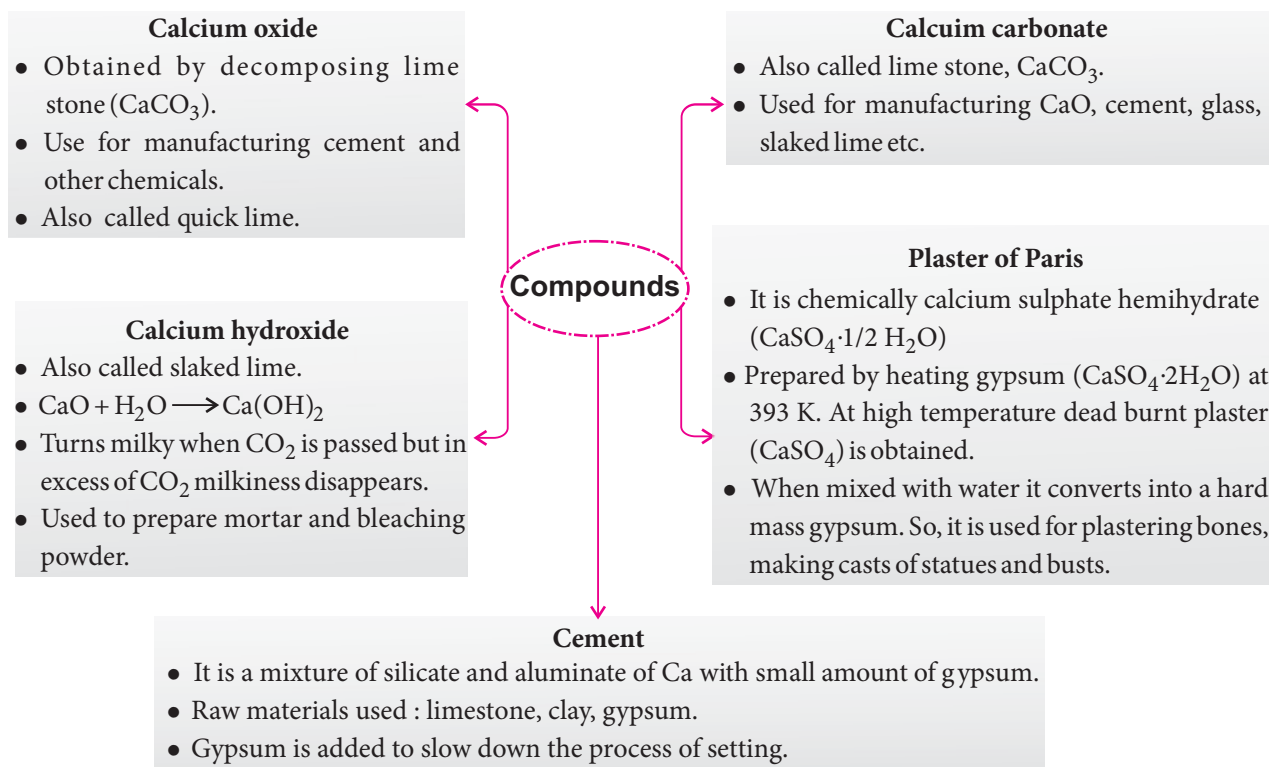
DIAGONAL RELATIONSHIP

- The similarity in properties of elements present diagonally is called *diagonal relationship*.
- The similarity in properties like electronegativity, ionisation energy, size of ion cause diagonal relation. Thus, Li shows similar properties as Mg and Be shows properties similar to Al.

| | Group 1 | Group 2 | Group 13 | Group 14 |
|---------------|---------|---------|----------|----------|
| Second period | Li | Be | B | C |
| Third period | Na | Mg | Al | Si |

Arrows indicate diagonal relationships: Li to Mg, Be to Al, and B to Si.

SOME IMPORTANT COMPOUNDS



Production of hydrogen from water by hybrid catalyst !

Finding a practical, inexpensive and non-toxic way to produce large amounts of hydrogen gas especially by splitting water into its component parts, hydrogen and oxygen has been a challenge. “With the massive consumption of fossil fuels and its detrimental impact on the environment, methods of generating clean power are urgent,” the researchers wrote. “Hydrogen is an ideal carrier for renewable energy; however, hydrogen generation is inefficient because of the lack of robust catalysts that are substantially cheaper than platinum.” Platinum catalysts have the highest efficiency rate for hydrogen evolution. But platinum is rare, difficult to extract and too expensive for practical use. Their hybrid catalyst is composed of molybdenum sulfoselenide particles with vertically aligned layers on a 3-D porous conductive nickel diselenide scaffold. Testing determined that the hybrid catalyst required 69 millivolts from an external energy source to achieve a current density of 10 milliamps per square centimeter, which the researchers said is much better than many previously reported tests. In this case, the current “splits” the water, converting it to hydrogen at the cathode. Achieving the necessary current density with lower voltage improves energy conversion efficiency and reduces preparation costs.

SPEED PRACTICE

- Which of the following can adsorb largest volume of hydrogen gas?
(a) Finely divided platinum
(b) Finely divided nickel
(c) Colloidal palladium
(d) Colloidal platinum
- Slaked lime is obtained when water is added to
(a) $\text{CaSO}_4 \cdot \frac{1}{2} \text{H}_2\text{O}$ (b) CaCl_2
(c) CaO (d) CaCO_3
- Which one of the following statements about water is false?
(a) Water is oxidised to oxygen during photosynthesis.
(b) Water can act both as an acid and as a base.
(c) There is extensive intramolecular hydrogen bonding in the condensed phase.
(d) Ice formed by heavy water sinks in normal water. (JEE Main 2016)
- Mark the incorrect statement.
(a) Lithopone is cheap and possess good covering power.
(b) Lithopone is yellow pigment.
(c) Lithopone is prepared by mixing barium sulphide and zinc sulphate.
(d) Lithopone is a mixture of barium sulphate and zinc sulphide.
- H_2O_2 can be obtained when following reacts with H_2SO_4 except with
(a) PbO_2 (b) BaO_2
(c) Na_2O_2 (d) SrO_2
- The correct order of equivalent conductance at infinite dilution of LiCl , NaCl and KCl is
(a) $\text{LiCl} > \text{NaCl} > \text{KCl}$
(b) $\text{KCl} > \text{NaCl} > \text{LiCl}$
(c) $\text{NaCl} > \text{KCl} > \text{LiCl}$
(d) $\text{LiCl} > \text{KCl} > \text{NaCl}$
- Hydrogen peroxide on treatment with an acid solution of titanium salt gives
(a) yellow colour (b) red colour
(c) blue colour (d) white colour.
- The main oxides formed on combustion of Li , Na and K in excess of air are, respectively
(a) Li_2O , Na_2O and KO_2
(b) LiO_2 , Na_2O_2 and K_2O
(c) Li_2O_2 , Na_2O_2 and KO_2
(d) Li_2O , Na_2O_2 and KO_2 (JEE Main 2016)
- Which is most volatile out of *o*-, *m*- and *p*-nitrophenol?
(a) *o*- (b) *m*-
(c) *p*- (d) All are equally volatile.
- Mg and Zn do not resemble in which of the following properties?
(a) Their oxides are amphoteric.
(b) Their carbonates on heating form metal oxides.
(c) They are widely used as electrodes.
(d) They are used to prevent corrosion.
- Which of the following easily reacts with water producing hydrogen?
(a) PH_3 (b) B_2H_6
(c) CH_4 (d) H_2S
- Which of the following has maximum lattice energy?
(a) Li_2O (b) Na_2O
(c) MgO (d) BaO
- The molecular formula of a commercial resin used for exchanging Ions in water softening is $\text{C}_8\text{H}_7\text{SO}_3\text{Na}$ (Mol. wt. 206). What would be the maximum uptake of Ca^{2+} ions by the resin when expressed in mole per gram resin?
(a) $\frac{2}{309}$ (b) $\frac{1}{412}$ (c) $\frac{1}{103}$ (d) $\frac{1}{206}$
- In which of the following cases the value of x is maximum?
(a) $\text{CaSO}_4 \cdot x\text{H}_2\text{O}$
(b) $\text{BaSO}_4 \cdot x\text{H}_2\text{O}$
(c) $\text{MgSO}_4 \cdot x\text{H}_2\text{O}$
(d) All have the same value of x
- The volume of oxygen liberated at NTP from 15 mL of 20 volume H_2O_2 is
(a) 250 mL (b) 300 mL
(c) 150 mL (d) 200 mL

16. The product obtained as a result of a reaction of nitrogen with CaC_2 is
 (a) CaCN_3 (b) Ca_2CN
 (c) $\text{Ca}(\text{CN})_2$ (d) CaCN
(NEET Phase-I 2016)
17. The label on a bottle of H_2O_2 solution reads as '10 volume'. The concentration of H_2O_2 in percentage by volume is
 (a) 4.05% (b) 3.03%
 (c) 6.06% (d) 2.03%
18. The pair of amphoteric hydroxides is
 (a) $\text{Al}(\text{OH})_3$, LiOH (b) $\text{Be}(\text{OH})_2$, $\text{Mg}(\text{OH})_2$
 (c) $\text{B}(\text{OH})_3$, $\text{Be}(\text{OH})_2$ (d) $\text{Be}(\text{OH})_2$, $\text{Zn}(\text{OH})_2$
19. The number of water molecules is maximum in
 (a) 1.8 g of water (b) 18 g of water
 (c) 18 moles of water (d) 18 molecules of water.
(AIPMT 2015)
20. Which one of the following alkaline earth metal sulphates has its hydration enthalpy greater than its lattice enthalpy?
 (a) BaSO_4 (b) SrSO_4
 (c) CaSO_4 (d) BeSO_4
21. Temporary hardness and permanent hardness in water can be removed respectively by addition of
 (a) CaO , CaCO_3 (b) CaO , Na_2CO_3
 (c) Na_2CO_3 , CaO (d) NaHCO_3 , CaCl_2
22. If strontium and sulphur combine, the formula for the product would most likely be
 (a) Sr_2S_3 (b) SrS_3
 (c) SrS (d) Sr_3S
23. Which of the following statements about hydrogen is incorrect?
 (a) Hydronium ion, H_3O^+ exists in solution.
 (b) Dihydrogen does not act as a reducing agent.
 (c) Hydrogen has three isotopes of which tritium is the most common.
 (d) Hydrogen never acts as cation in ionic salts.
(NEET Phase-I 2016)
24. The decreasing order of solubility of alkaline earth metal hydroxides $[\text{M}(\text{OH})_2]$ is
 (a) $\text{Be} < \text{Mg} < \text{Ca} < \text{Sr} < \text{Ba}$
 (b) $\text{Ba} > \text{Sr} > \text{Ca} > \text{Mg} > \text{Be}$
 (c) $\text{Mg} < \text{Be} < \text{Ca} < \text{Ba} < \text{Sr}$
 (d) $\text{Be} = \text{Mg} > \text{Ca} > \text{Sr} > \text{Ba}$
25. Epsom salt is
 (a) $\text{BaSO}_4 \cdot 2\text{H}_2\text{O}$ (b) $\text{CaSO}_4 \cdot \text{H}_2\text{O}$
 (c) $\text{MgSO}_4 \cdot 2\text{H}_2\text{O}$ (d) $\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$
26. Permutit is a technical name given to
 (a) aluminates of Ca and Na
 (b) hydrated silicates of Al and Na
 (c) silicates of Ca and Na
 (d) silicates of Ca and Mg.
27. In context with beryllium, which one of the following statements is incorrect?
 (a) It is rendered passive by nitric acid.
 (b) It forms Be_2C .
 (c) Its salts rarely hydrolyse.
 (d) Its hydride is electron-deficient and polymeric.
(NEET Phase-II 2016)
28. 100 mL of tap water containing $\text{Ca}(\text{HCO}_3)_2$ was titrated with $N/50$ HCl with methyl orange as indicator. If 30 mL of HCl were required, the temporary hardness as parts of CaCO_3 per 10^6 parts of water is
 (a) 150 ppm (b) 300 ppm
 (c) 450 ppm (d) 600 ppm
29. A 5.0 mL of H_2O_2 solution liberates 0.508 g I_2 from an acidified KI solution. Calculate volume strength of H_2O_2 solution.
 (a) 4.48 volume (b) 5.36 volume
 (c) 4.12 volume (d) 4.30 volume
30. Select correct statement(s).
 (a) CaCO_3 is more soluble in a solution of CO_2 than in H_2O .
 (b) Na_2CO_3 is converted to Na_2O and CO_2 on heating.
 (c) Li_2CO_3 is thermally stable.
 (d) Presence of CaCl_2 or CaSO_4 in water causes temporary hardness.

SOLUTIONS

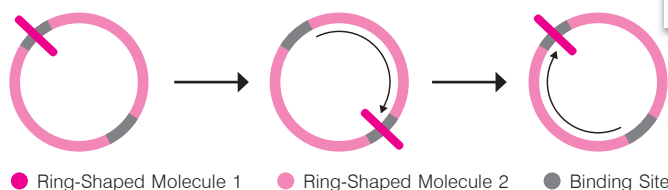
1. (c) : Order of adsorption of H_2 (occlusion) is :
 Colloidal palladium > Palladium > Platinum > Gold > Nickel
2. (c) : The slaked lime is calcium hydroxide. It is obtained when water is added to CaO (Lime).

$$\text{CaO} + \text{H}_2\text{O} \rightarrow \text{Ca}(\text{OH})_2$$
3. (c) : In the condensed phase, there is extensive intermolecular hydrogen bonding in water molecules but not intramolecular hydrogen bonding.
4. (b) : Lithopone ($\text{ZnS} + \text{BaSO}_4$) is used as a white pigment.

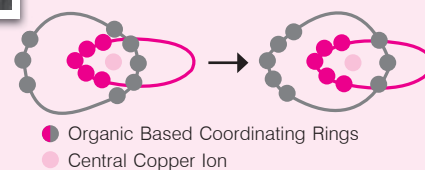
NEWS CORNER

The Nobel prize in Chemistry 2016 was awarded to Jean-Pierre Sauvage, Sir J. Fraser Stoddart and Bernard L. Feringa for the design and production of molecular machines with controllable movements.

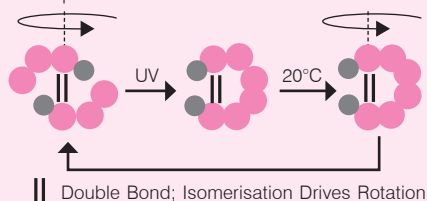
Molecular machines are a thousand times thinner than a human hair. The machines are formed from mechanically interlocked ring shaped molecules which are able to move relative to each other.



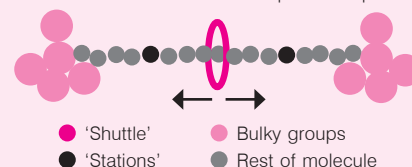
Jean-Pierre Sauvage created a pair of interlocking ring (called a catenane). One ring could rotate around the other when energy was added.



Bernard L. Feringa produced the first molecular motor by constructing a molecule that responded to light and heat and spun in a particular direction.



Sir J. Fraser Stoddart made a ring-shaped molecule attached to an axle (a rotaxane) which could shuttle up and down. He also helped produce a rotaxane based computer chip.



World's Smallest Machines

The technology is already being used to create medical micro-robots and self-healing materials that can repair themselves without human intervention.

In living organisms, cells work as molecular machines to power our organs, regulate temperature and repair damage. The Nobel trio were among the first to replicate this kind of function in synthetic molecules, by working out how to convert chemical energy into mechanical motion.

The advances have allowed scientists to develop materials that will reconfigure and adapt by themselves depending on their environment - for instance contracting with heat, or opening up to deliver drugs when they arrive at a target site in the body.

The first step towards a molecular machine was taken by Jean-Pierre Sauvage in 1983, when he succeeded in linking two ring-shaped molecules together to form a chain, called a catenane. Normally, molecules are joined by strong covalent bonds in which the atoms share electrons, but in the chain they were instead linked by a freer mechanical bond. For a machine to be able to perform a task it must

consist of parts that can move relative to each other. The two interlocked rings fulfilled exactly this requirement.

The second step was taken by Sir J. Fraser Stoddart in 1991, when he developed a rotaxane. He threaded a molecular ring onto a thin molecular axle and demonstrated that the ring was able to move along the axle. Among his developments based on rotaxanes are a molecular lift, a molecular muscle and a molecule-based computer chip.

Bernard Feringa was the first person to develop a molecular motor; in 1999 he got a molecular rotor blade to spin continually in the same direction. Using molecular motors, he has rotated a glass cylinder that is 10,000 times bigger than the motor and also designed a nanocar. 2016's Nobel Laureates in Chemistry have taken molecular systems out of equilibrium's stalemate and into energy-filled states in which their movements can be controlled. In terms of development, the molecular motor is at the same stage as the electric motor was in the 1830s. Molecular machines will most likely be used in the development of things such as new materials, sensors and energy storage systems.

EXAMINER'S MIND CLASS XI



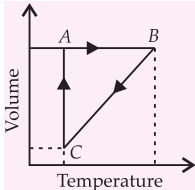
The questions given in this column have been prepared strictly on the basis of NCERT Chemistry for Class XI. This year JEE (Main & Advanced)/NEET/AIIMS have drawn their papers heavily from NCERT books.

| | |
|---------------|---|
| Section - I | Q. 1 to 10 Only One Option Correct Type MCQs. |
| Section - II | Q. 11 to 13 More than One Options Correct Type MCQs. |
| Section - III | Q. 14 to 17 Paragraph Type MCQs having Only One Option Correct. |
| Section - IV | Q. 18 & 19 Matching List Type MCQs having Only One Option Correct. |
| Section - V | Q. 20 to 22 Assertion Reason Type MCQs having Only One Option Correct. Mark the correct choice as : (a) If both assertion and reason are true and reason is the correct explanation of assertion. (b) If both assertion and reason are true but reason is not the correct explanation of assertion. (c) If assertion is true but reason is false. (d) If both assertion and reason are false. |
| Section - VI | Q. 23 to 25 Integer Value Correct Type Questions having Single Digit Integer Answer, ranging from 0 to 9 (both inclusive). |

THERMODYNAMICS

SECTION - I

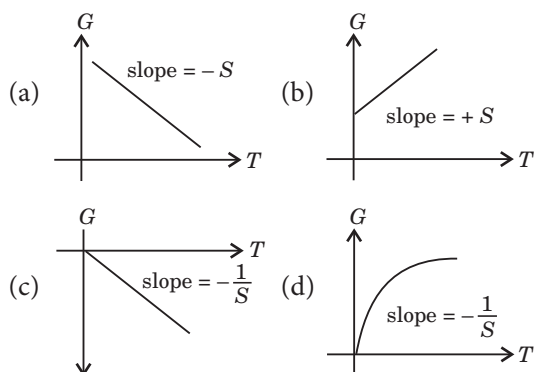
Only One Option Correct Type

- Five moles of a gas is put through a series of changes as shown graphically in a cyclic process. The processes $A \rightarrow B$, $B \rightarrow C$ and $C \rightarrow A$ respectively are

 - isochoric, isobaric, isothermal
 - isobaric, isochoric, isothermal
 - isothermal, isobaric, isochoric
 - isochoric, isothermal, isobaric.
- What is the equilibrium constant, K for the following reaction at 400 K?
 $2\text{NOCl}_{(g)} \rightleftharpoons 2\text{NO}_{(g)} + \text{Cl}_{2(g)}$
 $\Delta H = 77.2 \text{ kJ mol}^{-1}$ and $\Delta S = 122 \text{ J K}^{-1} \text{ mol}^{-1}$ at 400 K.
 - 3.708
 - 1.95×10^{-4}
 - 2.8×10^4
 - 1.67×10^{-5}
- Consider a class room of dimensions $(5 \times 10 \times 3) \text{ m}^3$ at temperature 20°C and pressure 1 atm. There are 50 people in the room, each losing energy at the

average of 150 W. Assuming that the walls, ceiling, floor and furniture are perfectly insulated and none of them are absorbing heat, how much time in seconds will be needed for raising the temperature of air in the room to body temperature, i.e., 37°C ? For air, $C_p = 7/2 R$. Loss of air to the outside as the temperature rises may be neglected.
 (a) 411.3 (b) 412.1 (c) 332.5 (d) 443.3

- Which one of the following statements is false?
 - Work is a state function.
 - Temperature is a state function.
 - Change in the state is completely defined when the initial and final states are specified.
 - Work appears at the boundary of the system.
- What is the enthalpy change for the reaction, $\text{H}_{2(g)} + \text{C}_2\text{H}_{4(g)} \rightarrow \text{C}_2\text{H}_6(g)$?
 The bond energies are given below :
 $B.E.(\text{H}-\text{H}) = 103$, $B.E.(\text{C}-\text{H}) = 99$,
 $B.E.(\text{C}-\text{C}) = 80$ and $B.E.(\text{C}=\text{C}) = 145 \text{ kcal/mol}$ respectively.
 - $-10 \text{ kcal mol}^{-1}$
 - $+10 \text{ kcal mol}^{-1}$
 - $-30 \text{ kcal mol}^{-1}$
 - $+30 \text{ kcal mol}^{-1}$

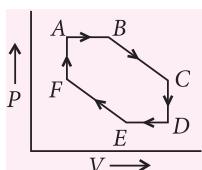
6. The entropy change involved in the isothermal reversible expansion of 2 moles of an ideal gas from a volume of 10 dm^3 to a volume of 100 dm^3 at 27°C is
 (a) $38.3 \text{ J mol}^{-1}\text{K}^{-1}$ (b) $35.8 \text{ J mol}^{-1}\text{K}^{-1}$
 (c) $32.3 \text{ J mol}^{-1}\text{K}^{-1}$ (d) $42.3 \text{ J mol}^{-1}\text{K}^{-1}$
7. Standard enthalpy of vaporisation of benzene at its boiling point is 30.8 kJ mol^{-1} . For what time in seconds a 100 W electric heater have to operate in order to vaporise a 100 g sample of benzene at its boiling temperature?
 (a) 300 (b) 368 (c) 408.6 (d) 395
8. The heat of neutralisation of a strong acid and a strong alkali is 57.0 kJ mol^{-1} . The heat released in kJ when 0.5 mole of HNO_3 solution is mixed with 0.2 mole of KOH is
 (a) 57.0 (b) 11.4 (c) 28.5 (d) 34.9
9. In a closed insulated container, a liquid is stirred with a paddle to increase its temperature. Which of the following conditions is true for this process?
 (a) $\Delta U = w \neq 0, q = 0$ (b) $\Delta U \neq 0, q = 0, w = 0$
 (c) $\Delta U = w = q = 0$ (d) $\Delta U = 0, q \neq 0, w = 0$
10. For a pure substance, a plot of Gibbs free energy (G) against temperature at constant pressure is



SECTION - II

More than One Options Correct Type

11. Which inferences have been accurately drawn from the given plot?



(Temperature at A, B and F is T_1 and at C, D and E is T_2 . $T_1 > T_2$)

- (a) $B \rightarrow C$ is an adiabatic expansion and temperature falls from T_1 to T_2 .
 (b) $E \rightarrow F$ is an adiabatic compression and temperature increases from T_2 to T_1 .
 (c) $F \rightarrow A$ is an isothermal and isochoric process.
 (d) $C \rightarrow D$ is an adiabatic and isobaric process.

12. Which of the following statements is/are correct?
 (a) Heat like work is a way of transferring energy.
 (b) Heat is not a property of the system, whereas the temperature is a property of the system.
 (c) Heat is manifested only at the boundary of the system and surroundings.
 (d) None of the above.
13. If x and y are extensive properties, then which one of the following is correct?
 (a) $(x + y)$ is an extensive variable.
 (b) (x / y) is an intensive variable.
 (c) (dx / dy) is an intensive variable.
 (d) $(x - y)$ is an intensive variable.

SECTION - III

Paragraph Type

Paragraph for Questions 14 and 15

Gibbs energy or Gibbs function, G is given as

$$G = H - TS$$

Gibbs function, G is an extensive property and a state function.

The change in Gibbs energy for the system, ΔG_{sys} can be written as

$$\Delta G_{\text{sys}} = \Delta H_{\text{sys}} - T\Delta S_{\text{sys}} - S_{\text{sys}}\Delta T$$

At constant temperature, $\Delta T = 0$

$$\therefore \Delta G_{\text{sys}} = \Delta H_{\text{sys}} - T\Delta S_{\text{sys}}$$

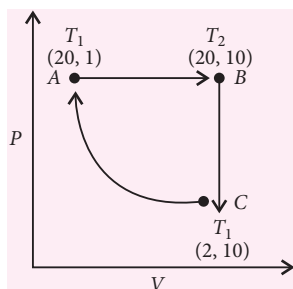
ΔG gives a criteria for spontaneity at constant pressure and temperature.

- (i) If ΔG is negative (< 0), the process is spontaneous.
 (ii) If ΔG is positive (> 0), the process is non-spontaneous.
 Gibbs energy for a reaction in which all reactants and products are in standard state, $\Delta_r G^\circ$ is related to the equilibrium constant of the reaction as follows :
 or $\Delta_r G^\circ = -RT \ln K$

14. In which of the following processes, the process is always feasible?
 (a) $\Delta H > 0, \Delta S > 0$ (b) $\Delta H < 0, \Delta S > 0$
 (c) $\Delta H > 0, \Delta S < 0$ (d) $\Delta H < 0, \Delta S < 0$
15. If ΔG° for a reaction is $46.06 \text{ kcal mol}^{-1}$ at 27°C , K_p for the reaction is
 (a) 10^{-8} (b) $10^{-22.22}$
 (c) $10^{-33.55}$ (d) none of these.

Paragraph for Questions 16 and 17

One mole of a perfect monoatomic gas is put through a cycle consisting of the following three reversible steps :



CA : Isothermal compression from 2 atm and 10 litres to 20 atm and 1 litre.

AB : Isobaric expansion to return the gas to the original volume of 10 litres with T going from T_1 to T_2 .

BC : Cooling at constant volume to bring the gas to the original pressure and temperature.

The steps are shown schematically in the figure.

16. T_1 and T_2 respectively are
 (a) 243.6 K and 250.3 K (b) 243.6 K and 2436 K
 (c) 2503.4 K and 243.6 K (d) 2436 K and 243.6 K
17. Work done and ΔU for path CA respectively are
 (a) + 1122.02 and 0 cal
 (b) 1.12202 and 112.202 kcal
 (c) 4690.04 and 469.004 J
 (d) 112.02 and 469.004 J

SECTION - IV

Matching List Type

18. Match the List I with List II and select the correct answer using the codes given below the lists :

| List I | | List II | | |
|--------|--|----------|------------------------------|----------|
| (P) | A process carried out infinitesimally slowly | (1) | Adiabatic | |
| (Q) | A process in which no heat enters or leaves the system | (2) | $\Delta U = 0, \Delta H = 0$ | |
| (R) | A process carried out at constant temperature | (3) | Reversible | |
| (S) | Cyclic process | (4) | Isothermal | |
| | P | Q | R | S |
| (a) | 1 | 2 | 3 | 4 |
| (b) | 4 | 1 | 2 | 3 |
| (c) | 3 | 1 | 4 | 2 |
| (d) | 2 | 3 | 4 | 1 |

19. Match the List I with List II and select the correct answer using the codes given below the lists :

| List I | List II (ΔH in kJ mol^{-1}) | | |
|--|---|----------|----------|
| (P) $\text{HCl}_{(aq)} + \text{NaOH}_{(aq)} \rightarrow \text{NaCl}_{(aq)} + \text{H}_2\text{O}_{(l)}$ | (1) -57.3 | | |
| (Q) $\text{HF}_{(aq)} + \text{NaOH}_{(aq)} \rightarrow \text{NaF}_{(aq)} + \text{H}_2\text{O}_{(l)}$ | (2) 6.00 | | |
| (R) $\text{H}_2\text{O}_{(s)} \rightarrow \text{H}_2\text{O}_{(l)}$ | (3) Higher than 57.3 | | |
| (S) $\text{HCl}_{(aq)} + \text{NaOH}_{(aq)} \rightarrow \text{NaCl}_{(aq)} + \text{H}_2\text{O}_{(l)}$ (in non-polar aprotic solvent) | (4) Lower than 57.3 | | |
| P | Q | R | S |
| (a) 1 | 2 | 3 | 4 |
| (b) 3 | 4 | 1 | 2 |
| (c) 2 | 3 | 1 | 4 |
| (d) 1 | 3 | 2 | 4 |

SECTION - V

Assertion Reason Type

20. **Assertion :** Work done during free expansion of an ideal gas whether reversible or irreversible is positive.
Reason : During free expansion, external pressure is always less than the pressure of the system.
21. **Assertion :** Zeroth law can also be termed as law of thermal equilibrium.
Reason : Two objects in thermal equilibrium with the third one, are in thermal equilibrium with each other.
22. **Assertion :** The increase in internal energy (ΔE) for the vaporisation of one mole of water at 1 atm and 373 K is zero.
Reason : For all isothermal processes, $\Delta E = 0$.

SECTION - VI

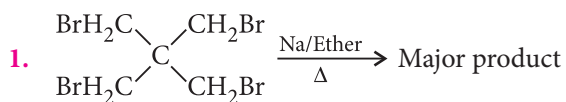
Integer Value Correct Type

23. A solution of 500 mL of 0.2 M KOH and 500 mL of 0.2 M HCl is mixed and stirred, the rise in temperature is T_1 . The experiment is repeated using 250 mL of each of the solution and rise in temperature is T_2 . The ratio T_1/T_2 is $x : y$. The value of x is
24. Standard entropy of X_2 , Y_2 and XY_3 are 60, 40 and $50 \text{ J K}^{-1} \text{ mol}^{-1}$ respectively. For the reaction, $1/2 X_2 + 3/2 Y_2 \rightarrow XY_3$, $\Delta H = -30 \text{ kJ}$, to be at equilibrium, the temperature is $(x^2 + 145x) \text{ K}$. The value of x is
25. ΔC_p of the following is $-x(R)$.
 $\text{N}_{2(g)} + 3\text{H}_{2(g)} \rightarrow 2\text{NH}_{3(g)}$, the value of x is

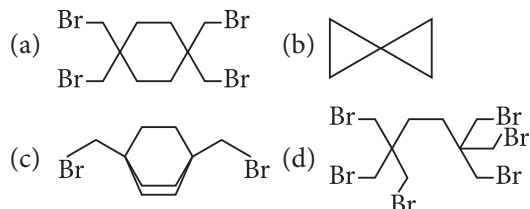
HYDROCARBONS

SECTION - I

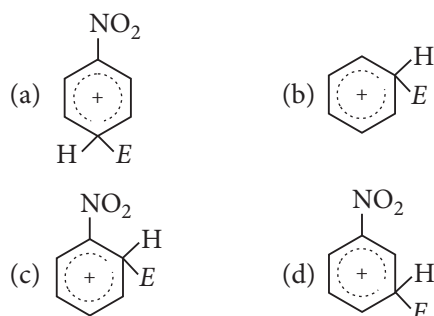
Only One Option Correct Type



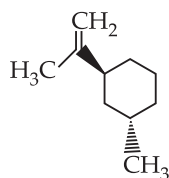
The major product is



2. The electrophile, E^+ attacks the benzene ring to generate the σ -complex of the following compounds. Which σ -complex is of lowest energy?

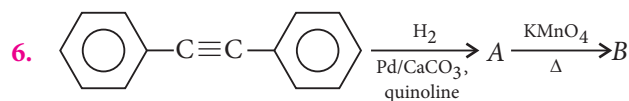


3. Excess of CH_3COOH is reacted with $\text{CH} \equiv \text{CH}$ in the presence of Hg^{2+} , the product is
 (a) $\text{CH}_3\text{CH}(\text{OOCCH}_3)_2$
 (b) $\text{CH}_2 = \text{CH}(\text{OCOCH}_3)$
 (c) $(\text{CH}_3\text{COO})\text{CH}_2 - \text{CH}_2(\text{OOCCH}_3)$
 (d) None of these.
4. The correct IUPAC name of the following compound is



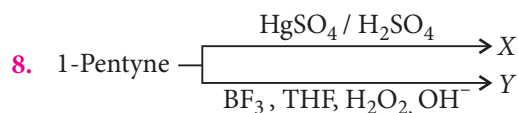
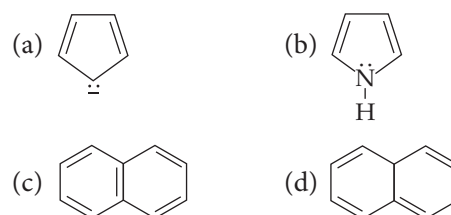
- (a) *cis*-1-isopropenyl-3-methylcyclohexane
 (b) *trans*-1-methyl-3-isopropenylcyclohexane
 (c) *trans*-2-(methylcyclohexane)prop-1-ene
 (d) *trans*-1-isopropenyl-3-methylcyclohexane
5. Which type of isomerism is shown by 2, 3-dichlorobutane?

- (a) Structural (b) Geometric
 (c) Optical (d) Diastereo



Identify A and B.

- (a) $\text{C}_6\text{H}_5\text{CH}=\text{CHC}_6\text{H}_5$, $\text{C}_6\text{H}_5\text{CH}_2\text{COOH}$
 (b) $\text{C}_6\text{H}_5\text{CH}=\text{CHC}_6\text{H}_5$, $\text{C}_6\text{H}_5\text{COOH}$
 (c) $\text{C}_6\text{H}_5\text{CH}_2\text{CH}_3$, $\text{C}_6\text{H}_5\text{CHO}$
 (d) $\text{C}_6\text{H}_5\text{CH}=\text{CHC}_6\text{H}_5$, $\text{C}_6\text{H}_5\text{CHO}$
7. Which of the following is not an aromatic compound?



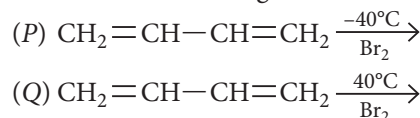
X and Y can be distinguished by

- (a) silver-mirror test (b) iodoform test
 (c) both (a) and (b) (d) None of these.
9. Baeyer's reagent is used in the laboratory for
 (a) oxidation process
 (b) detection of glucose
 (c) detection of double bond
 (d) reduction process.
10. The maximum number of isomers for an alkane with the molecular formula C_5H_{12} is
 (a) 2 (b) 5 (c) 4 (d) 3

SECTION - II

More than One Options Correct Type

11. Which of the following statements is/are correct?



- (a) In P, the major product is 3, 4-dibromobut-1-ene and minor product is 1, 4-dibromobut-2-ene.
 (b) In P, the major product is 1, 4-dibromobut-2-ene and 3, 4-dibromobut-1-ene.

- (c) In Q, the major product is
1, 4-dibromobut-2-ene and minor product is
3, 4-dibromobut-1-ene.
(d) In Q, the product is only 3, 4-dibromobut-2-ene.

12. Nitration of propane with concentrated HNO_3 gives
(a) CH_3NO_2 (b) $\text{CH}_3\text{CH}_2\text{CH}_2\text{NO}_2$
(c) $\text{CH}_3-\underset{\text{NO}_2}{\text{CH}}-\text{CH}_3$ (d) $\text{CH}_3\text{CH}_2\text{NO}_2$

13. Which of the following are *o*, *p*-directing groups?
(a) Toluene (b) Aniline
(c) Nitrobenzene (d) Benzaldehyde

SECTION - III

Paragraph Type

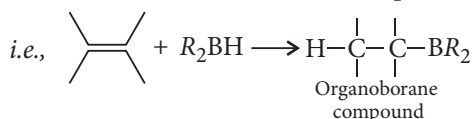
Paragraph for Questions 14 and 15

When monosubstituted benzene is subjected to further substitution, three possible disubstituted products are not formed in equal amounts. Two types of behaviour are observed. Either *ortho* and *para* products or *meta* product is predominantly formed. This behaviour depends on the nature of the substituent already present in the benzene ring and not on the nature of the entering group. This is known as directive influence of substituents.

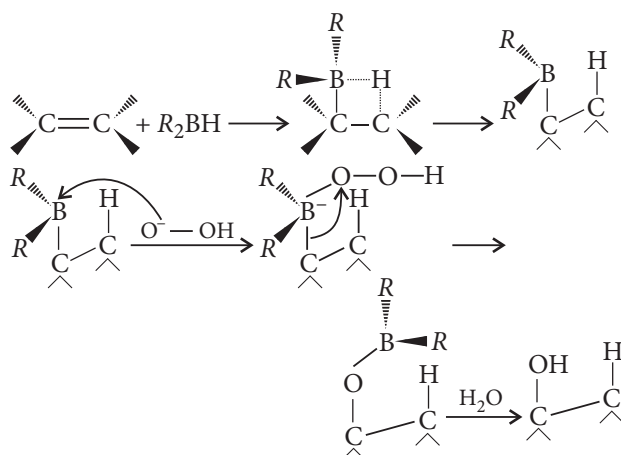
14. Which of the following compounds reacts slower than benzene in electrophilic bromination?
(a) $\text{C}_6\text{H}_5\text{NO}_2$ (b) $\text{C}_6\text{H}_5\text{NH}_2$
(c) $\text{C}_6\text{H}_5\text{OH}$ (d) $\text{C}_6\text{H}_5\text{CH}_3$
15. A deactivating group in electrophilic substitution reaction
(a) deactivates only *ortho*- and *para*- positions.
(b) deactivates only *meta*- position.
(c) deactivates *meta*-position more than *ortho*- and *para*- positions.
(d) deactivates *ortho*- and *para*- positions more than *meta*- position.

Paragraph for Questions 16 and 17

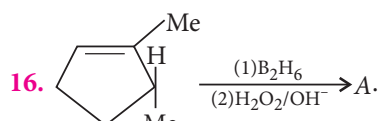
Hydroboration is a reaction in which the boron hydride acts as an electrophile. R_2BH adds to a carbon-carbon double bond which acts as a nucleophile



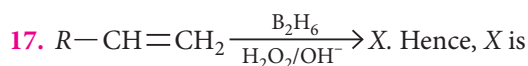
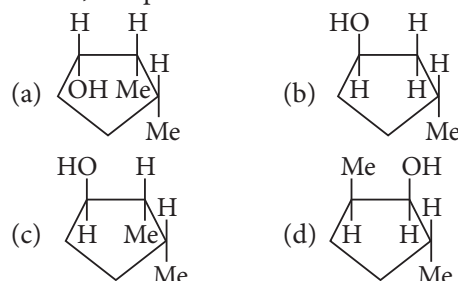
The organoborane compound then is oxidised by treatment with hydrogen peroxide in aqueous medium to form alcohol. The $-\text{OH}$ group enters the carbon atom from the same side where the boron atom was present.



Hence, this reaction is highly regioselective and the boron atom attaches to that carbon atom which is less sterically hindered.



Hence, compound A is



- (a) $\text{R}-\text{CH}_2\text{OH}$ (b) $\text{R}-\overset{\text{O}}{\parallel}{\text{C}}-\text{CH}_3$
(c) $\text{R}-\text{CHO}$ (d) $\text{R}-\text{CH}_2\text{CH}_2\text{OH}$

SECTION - IV

Matching List Type

18. Match the List I with List II and select the correct answer using the codes given below the lists :

| List I | List II |
|---|-------------------------|
| P. Benzene + $\text{Cl}_2 \xrightarrow{\text{AlCl}_3}$ | 1. Benzoic acid |
| Q. Benzene + $\text{CH}_3\text{Cl} \xrightarrow{\text{AlCl}_3}$ | 2. Methylphenyl ketone |
| R. Benzene + $\text{CH}_3\text{COCl} \xrightarrow{\text{AlCl}_3}$ | 3. Toluene |
| S. Toluene $\xrightarrow{\text{KMnO}_4/\text{NaOH}}$ | 4. Chlorobenzene |
| | 5. Benzene hexachloride |

| | P | Q | R | S |
|-----|---|---|---|---|
| (a) | 4 | 3 | 2 | 1 |
| (b) | 1 | 2 | 3 | 4 |
| (c) | 4 | 3 | 1 | 5 |
| (d) | 1 | 5 | 2 | 3 |

19. Match the List I with List II and select the correct answer using the codes given below the lists :

| List I | List II (Ozonolysis product) |
|----------------------|------------------------------|
| P. Propene | 1. Propan-1, 3-dial |
| Q. Hex-1,3, 5-triene | 2. Acetaldehyde |
| R. Benzene | 3. Formaldehyde |
| S. Cyclopropene | 4. Glyoxal |

| | P | Q | R | S |
|-----|-----|-----|-----|-----|
| (a) | 1,4 | 1,2 | 3 | 4 |
| (b) | 2,3 | 3,4 | 4 | 1 |
| (c) | 3,4 | 1 | 2,3 | 4 |
| (d) | 4 | 2,3 | 1 | 2,4 |

SECTION - V

Assertion Reason Type

20. **Assertion** : 1-Butene on reaction with HBr in the presence of a peroxide produces 1-bromobutane.

Reason : It involves the formation of a primary radical.

21. **Assertion** : Among isomeric pentanes, 2,2-dimethylpropane has the lowest boiling point.

Reason : Branching does not affect the boiling point.

22. **Assertion** : Addition of bromine to *trans*-2-butene yields *meso*-2,3-dibromobutane.

Reason : Bromine addition to an alkene is an electrophilic addition.

SECTION - VI

Integer Value Correct Type

23. Two cyclic dienes A and B have molecular formula C_6H_8 . The mixture of the two on reductive ozonolysis gave the following products : succinaldehyde, propan-1,3-dial and glyoxal. Mixture of A and B on hydrogenation produces only cyclohexane. The total sum of the positions of the double bonds in compounds A and B is

24. On monochlorination of 2-methylbutane, the total number of chiral compounds formed is

25. Number of carbon atoms in alkyne having molecular mass 96 is

SOLUTIONS

THERMODYNAMICS

1. (a)

2. (b): $\Delta G = \Delta H - T\Delta S$
 $= 77.2 - 400 \times 122 \times 10^{-3}$
 $= +28.4 \text{ kJ mol}^{-1} = 28400 \text{ J mol}^{-1}$

Further, $\Delta G = -2.303 RT \log K$
 or $28400 = -2.303 \times 8.314 \times 400 \times \log K$

$$\log K = -\frac{28400}{2.303 \times 8.314 \times 400}$$

$$\log K = -3.708$$

$$K = \text{Antilog}(-3.708) = 1.95 \times 10^{-4}$$

3. (a): $V_{\text{room}} \approx V_{\text{air}} = (5 \times 10 \times 3) \text{ m}^3$
 $= 150 \text{ m}^3 = 150 \times 10^6 \text{ cm}^3$

$$\therefore \text{Number of moles of air, } n = \frac{PV}{RT}$$

$$= \frac{1 \times 150 \times 10^6}{10^3 \times 0.0821 \times 293} = 6.236 \times 10^3$$

$$\text{Also, } \left(\frac{\delta H}{\delta T} \right)_p = C_p = \frac{\Delta H}{\Delta T} \quad (\text{for 1 mole})$$

$$\therefore \Delta H = n \cdot C_p \cdot \Delta T \quad (\text{for } n \text{ moles})$$

$$= 6.236 \times 10^3 \times \frac{7}{2} \times 8.314 \times (310 - 293)$$

$$= 3.085 \times 10^6 \text{ J}$$

Thus, heat needed to raise the temperature of the room to $37^\circ\text{C} = 3.085 \times 10^6 \text{ J}$

Also, heat released by 50 people = $150 \times 50 \text{ J/sec}$
 $= 7500 \text{ J/sec}$

$$\therefore \text{Time} = \frac{\text{Total heat required}}{\text{Heat given out per second}}$$

$$= \frac{3.085 \times 10^6}{7500} = 411.3 \text{ s}$$

4. (a)

5. (c)

6. (a): Entropy change for an isothermal process is,

$$\Delta S = 2.303 n R \log \left(\frac{V_2}{V_1} \right)$$

$$\Delta S = 2.303 \times 2 \times 8.314 \times \log \left(\frac{100}{10} \right)$$

$$= 38.294 \text{ J mol}^{-1} \text{ K}^{-1} \approx 38.3 \text{ J mol}^{-1} \text{ K}^{-1}$$

7. (d): 78 g benzene needs energy = 30.8 kJ

\therefore 100 g benzene will need energy

$$= \frac{30.8}{78} \times 100 = 39.5 \text{ kJ}$$

$$100 \text{ W} = 100 \text{ J/s} \quad (1 \text{ W} = 1 \text{ J s}^{-1})$$

$$100 \text{ J energy is given out in } 1 \text{ s}$$

$$\therefore 39500 \text{ J energy will be given out in } \frac{39500}{100} = 395 \text{ s}$$

8. (b): 0.2 mole will neutralise 0.2 mole of HNO_3 .

$$\therefore \text{Heat evolved} = 57 \times 0.2 = 11.4 \text{ kJ}$$

9. (a)

10. (a)

11. (a, b, c): $C \rightarrow D$ is an isochoric and isothermal process.

12. (a, b, c): Heat is not a state function, while temperature is a state function. Heat flowing into the system is positive and heat flowing out of the system is negative.

13. (a, b, c)

14. (b): A process is always feasible if it is accompanied with decrease in free energy, i.e., ΔG is -ve
 $\Delta G = \Delta H - T\Delta S$

Therefore, if ΔH is -ve and ΔS is +ve, then ΔG is always -ve.

15. (c): Here, $\Delta G = -2.303RT \log K_p$

$$46.06 \times 1000 \times 4.184 = -2.303 \times 8.314 \times 300 \log K_p$$

$$\therefore K_p = 10^{-33.55}$$

16. (b): For temperature T_1 (for C): $PV = nRT_1$

$$2 \times 10 = 1 \times 0.0821 \times T_1 \Rightarrow T_1 = 243.60 \text{ K}$$

$$\text{For temperature } T_2 \text{ (for C and B): } \frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$$

$$\frac{2 \times 10}{T_1} = \frac{20 \times 10}{T_2} \Rightarrow \frac{T_2}{T_1} = 10$$

$$\therefore T_2 = 243.60 \times 10 = 2436.0 \text{ K}$$

17. (a): Path CA, isothermal compression:

$$w = +2.303 nRT_1 \log \frac{V_i}{V_f}$$

V_i and V_f are initial volume and final volume at respective points.

$$= 2.303 \times 1 \times 2 \times 243.6 \log \frac{10}{1} = +1122.02 \text{ cal}$$

$$\therefore \Delta U = 0 \text{ for isothermal compression, so } q = w.$$

18. (c) 19. (d) 20. (d) 21. (a) 22. (a)

23. (1): Heat released (q_1) in the first experiment

$$= 0.1 \times 57 = 5.7 \text{ kJ}$$

and heat released (q_2) in the second experiment

$$= 0.05 \times 57 = 2.85 \text{ kJ}$$

$$\text{i.e., } q_1 = 2q_2$$

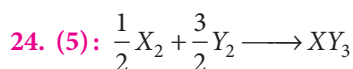
But $q = m \times s \times \Delta T$

$$m_1 = (500 + 500) \times 1 \text{ g/cc} = 1000 \text{ g}$$

$$m_2 = (250 + 250) \times 1 \text{ g/cc} = 500 \text{ g}$$

$$T = \frac{q}{m \times s}; T_1 = \frac{5.7}{1000 \times s}; T_2 = \frac{2.85}{500 \times s}$$

$$\therefore \frac{T_1}{T_2} = 1$$



$$\Delta S_{\text{reaction}} = S_{\text{products}} - S_{\text{reactants}}$$

$$\Delta S_{\text{reaction}} = 50 - \left(\frac{3}{2} \times 40 + \frac{1}{2} \times 60 \right) = -40 \text{ J mol}^{-1}$$

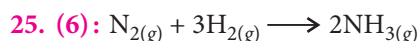
$$\Delta G = \Delta H - T\Delta S$$

At equilibrium, as $\Delta G = 0$

$$\therefore \Delta H = T\Delta S$$

$$\Rightarrow T = \frac{\Delta H}{\Delta S} = \frac{30 \times 10^3}{40} = 750 \text{ K}$$

$$\text{Now, } x^2 + 145x = 750 \therefore x = 5$$



$$\Delta C_p = -xR$$

$$\text{For diatomic gas, } C_p = \frac{7R}{2}$$

$$\text{For tetratomic gas, } C_p = 4R$$

$$C_{p(\text{reactants})} = \frac{7}{2}R + 3 \times \frac{7}{2}R = \frac{28R}{2} = 14R$$

$$C_{p(\text{product})} = 2 \times 4R = 8R$$

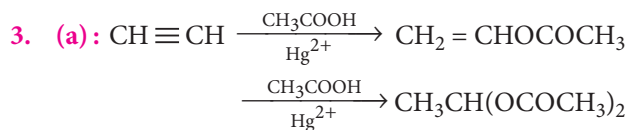
$$\Delta C_p = C_{p(\text{Products})} - C_{p(\text{reactants})} = 8R - 14R = -6R$$

$$\Rightarrow -xR = -6R \therefore x = 6 \quad (\because \Delta C_p = -xR)$$

HYDROCARBONS

1. (b)

2. (b)



4. (d)

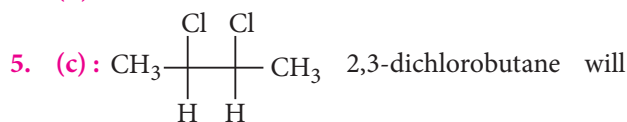
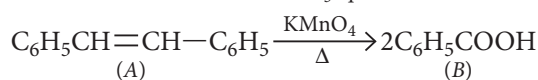
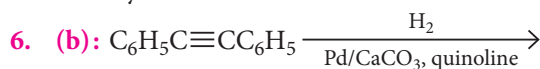


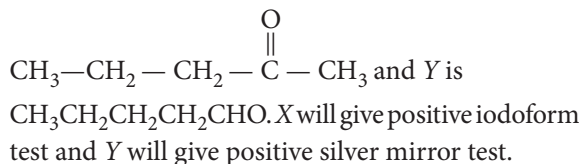
exhibit optical isomerism due to the presence of two asymmetric carbon atom.



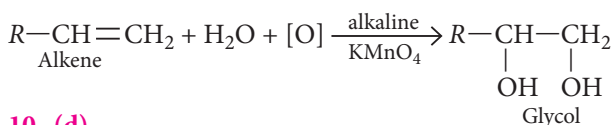
(A) (B)
syn-addition product

7. (d): Molecule has 8π -electrons, so does not follow Hückel's rule. The orbitals of one double bond are not in conjugation so it is not an aromatic compound but all the other given compounds follow Hückel's rule *i.e.*, $(4n + 2)\pi$ -electron rule.

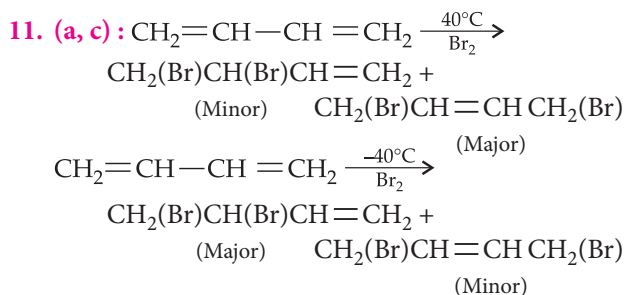
8. (c): In the reactions, X is



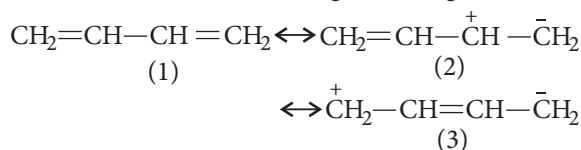
9. (c): Baeyer's reagent is alkaline KMnO_4 which is a mild oxidising agent. Alkenes react with Baeyer's reagent giving glycol and decolourise the pink colour of the latter. So this reagent is used for detection of double bond.



10. (d)



1,3-butadiene has the following resonating structures:



Contribution to resonance hybrid by (2) is predominant at low temperature.

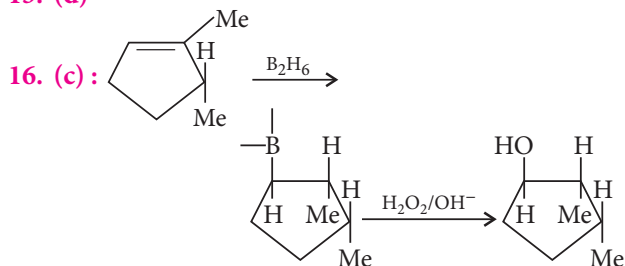
While contribution to resonance hybrid by (3) is predominant at high temperature.

12. (a, b, c, d)

13. (a, b)

14. (a)

15. (d)



17. (d)

18. (a)

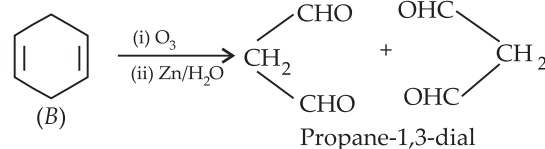
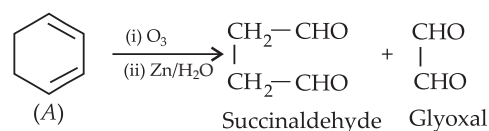
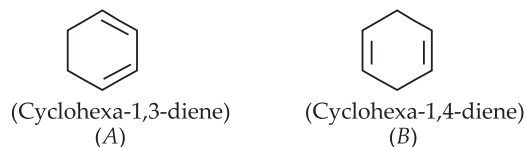
19. (b)

20. (c)

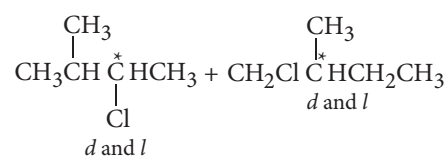
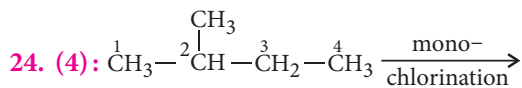
21. (c)

22. (b)

23. (9): Mixture of A and B gives cyclohexane. This implies that both A and B should be cyclohexadienes. The ozonolysis products suggest the presence of double bonds at 1 and 3-positions on one and at 1 and 4-positions in the other. Hence, A and B should be



Total sum of the positions of the double bonds in A and B = $1 + 3 + 1 + 4 = 9$.



(i) Chlorination at C-2 and C-4 produces no chiral compounds.

(ii) Chlorination at C-3 produces a chiral carbon marked with star (*d* and *l* form).

(iii) Chlorination at C-1 also produces a chiral carbon marked with star (*d* and *l* form).

25. (7): General formula for alkynes is $\text{C}_n\text{H}_{2n-2}$

$$\begin{aligned} \text{Molecular mass of alkyne is } &= 12n + 1(2n - 2) = 96 \\ &= 12n + 2n - 2 = 96 \\ \Rightarrow n &= 7 \end{aligned}$$

Hence, the alkyne having molecular mass 96 is C_7H_{12} .



ACE YOUR WAY

CBSE



Hydrogen The s-Block Elements

Time Allowed : 3 hours
Maximum Marks : 70

GENERAL INSTRUCTIONS

- (i) All questions are compulsory.
- (ii) Q. no. 1 to 5 are very short answer questions and carry 1 mark each.
- (iii) Q. no. 6 to 10 are short answer questions and carry 2 marks each.
- (iv) Q. no. 11 to 22 are also short answer questions and carry 3 marks each.
- (v) Q. no. 23 is a value based question and carries 4 marks.
- (vi) Q. no. 24 to 26 are long answer questions and carry 5 marks each.
- (vii) Use log tables if necessary, use of calculators is not allowed.

1. Name two compounds which retard the decomposition of hydrogen peroxide.
2. Sodium fire in the laboratory should not be extinguished by pouring water. Why?
3. Arrange the following hydrides in order of increasing electrical conductance : CaH_2 , BeH_2 and TiH_2
4. Why can caesium be used in photoelectric cell but lithium cannot?
5. A sample of hard water is allowed to pass through an anion exchanger. Will it produce lather with soap easily?
6. Identify (A), (B), (C) and (D) and give their chemical formulae.

$$(A) + \text{NaOH} \longrightarrow \text{NaCl} + \text{NH}_3 + \text{H}_2\text{O}$$

$$\text{NH}_3 + \text{CO}_2 + \text{H}_2\text{O} \longrightarrow (B)$$

$$(B) + \text{NaCl} \longrightarrow (C) + \text{NH}_4\text{Cl}$$

$$(C) \xrightarrow{\text{Heat}} \text{Na}_2\text{CO}_3 + \text{H}_2\text{O} + (D)$$
7. Calculate the volume strength of 1.6 M H_2O_2 solution.

OR

- Describe the industrial application of H_2 which depends on
- (i) the heat liberated when its atoms are made to combine on the surface of a metal
 - (ii) its effect on unsaturated organic system in the presence of catalyst.
8. Why is Li_2CO_3 decomposed at a lower temperature whereas Na_2CO_3 at higher temperature?
 9. Give reasons why does hydrogen resemble alkali metals?
 10. Calcium burns in air to produce a white powder which dissolves in water to produce a gas (A) and the solution is alkaline. The solution on exposure to air produces a thin solid layer of (B) on the surface. Identify (A) and (B).
 11. Answer the following :
 - (i) Can sea animals live in distilled water?
 - (ii) Why are detergents preferred over soaps for washing clothes?
 - (iii) Why do lakes freeze from top towards bottom?

12. Explain the following :
- Lithium cannot be stored in kerosene oil.
 - Alkali metals are very reactive in nature.
 - Alkali metals form only monovalent ions.

OR

Complete the following reactions :

- $\text{Ca} + \text{H}_2\text{O} \rightarrow$
 - $\text{BeO} + \text{NaOH} \rightarrow$
 - $\text{BaO}_2 + \text{H}_2\text{SO}_4 \rightarrow$
13. One litre sample of hard water contains 1 mg of CaCl_2 and 1 mg of MgCl_2 . Calculate the total hardness in terms of parts of CaCO_3 per 10^6 parts of water by weight.
14. Give reasons for the following :
- LiCl is more covalent than NaCl .
 - LiI has lower melting point than LiCl .
 - MgCl_2 is more covalent than NaCl .
15. Do you expect different products in solution when aluminium (III) chloride and potassium chloride are treated separately with (i) normal water (ii) acidified water, and (iii) alkaline water? Write equations wherever necessary.
16. Comment on each of the following observations :
- The mobilities of alkali metal ions in aqueous solution are in the order :
 $\text{Li}^+ < \text{Na}^+ < \text{K}^+ < \text{Rb}^+ < \text{Cs}^+$
 - Lithium is the only alkali metal that forms nitride directly.
 - E° for $M_{(aq)}^{2+} + 2e^- \rightarrow M_{(s)}$ is nearly constant, where $M = \text{Ca}, \text{Sr}$ and Ba .
17. Molecular hydrides are classified as electron deficient, electron precise and electron rich compounds. Explain each type with two examples.
18. What happens when :
- beryllium carbide reacts with water
 - magnesium nitrate is heated
 - quicklime is heated in electric furnace with powdered coke?
19. Discuss briefly demineralisation of water by ion exchange resin.
20. What happens when
- calcium nitrate is heated
 - quicklime is heated with silica
 - magnesium is burnt in air?

- Why are group 2 metals harder than those of group 1?
- Which two alkaline earth metals are kinetically inert towards oxygen and why?

22. What is the type of hardness expected for a sample of water containing magnesium bicarbonate? Give two methods for removal of this hardness.

23. Ria was drinking a cold drink with ice cubes in it and she noticed ice cubes were floating in the glass instead of sinking unlike other solid substances. Her mother explained the reason behind this phenomenon. Now answer the following questions :
- What did her mother explain?
 - What values are shown by Ria?
 - Why is water a polar solvent?

24. Give a comparative account of the alkali and alkaline earth metals with respect to the following characteristics :

- Tendency to form ionic/ covalent compounds
- Nature of oxides and their solubility in water
- Formation of oxosalts
- Solubility of oxosalts
- Thermal stability of oxosalts

OR

Ion of an element of group 1 participates in the transmission of nerve signals and transport of sugars and amino acids into cells. This element imparts yellow colour to the flame in flame test and forms an oxide and a peroxide with oxygen. Identify the element and write chemical reaction to show the formation of its peroxide. Why does the element impart colour to the flame?

- How can D_2O be prepared from water?
- Mention the physical properties in which D_2O differs from H_2O .
- Give at least three reactions of D_2O showing the exchange of hydrogen with deuterium.

OR

- An ionic hydride of an alkali metal has significant covalent character and is almost unreactive towards oxygen and chlorine. This is used in the synthesis of other useful hydrides. Write the formula of this hydride. Write its reaction with Al_2Cl_6 .
- Sodium forms a crystalline ionic solid with dihydrogen. The solid is non-volatile and non-conducting in nature. It reacts violently with

26. (i) Name the groups which constitute *s*-block elements.

(ii) Why cannot sodium and potassium be prepared by the electrolysis of their aqueous solution?

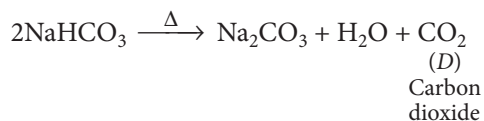
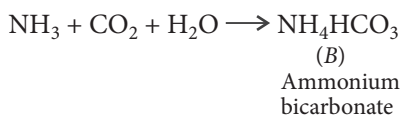
(iii) Why is the density of potassium less than that of sodium?

(iv) Why are alkali metals soft and have low melting points?

(v) What happens when potassium burns in air? Give chemical equation.

- (i) Compare the solubilities of carbonates and hydroxides of sodium and potassium with those of magnesium and calcium.
- (ii) What are the properties that make oxides of MgO and BeO useful for lining furnaces?
- (iii) What are the solutions of Ca(OH)_2 and Ba(OH)_2 called? How are they differentiated?

1. Acetanilide and glycerol retard the decomposition of H_2O_2 .
2. This is because sodium produces hydrogen gas with water which catches fire due to exothermic nature of the reaction.
$$2\text{Na}_{(s)} + 2\text{H}_2\text{O}_{(l)} \rightarrow 2\text{NaOH}_{(aq)} + \text{H}_{2(g)}; \Delta H = -368 \text{ kJ}$$
3. BeH_2 is significantly covalent, CaH_2 is ionic and TiH_2 is a metallic hydride hence, the order of increasing electrical conductance is $\text{BeH}_2 < \text{CaH}_2 < \text{TiH}_2$.
4. Caesium has the lowest while lithium has the highest ionisation enthalpy hence, caesium can lose electrons very easily and can be used in photoelectric cells.
5. No, Ca^{2+} and Mg^{2+} ions are still present in water and these will interact with soap to form curdy white precipitate.



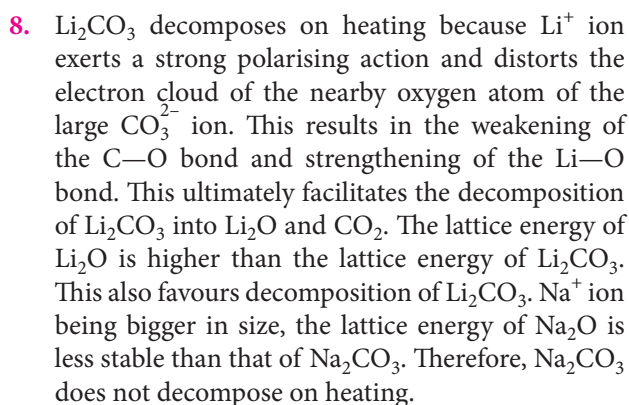
- $$2\text{H}_2\text{O}_2 \longrightarrow 2\text{H}_2\text{O} + \text{O}_2$$
- 68 g 1 mol = 22400 mL at STP
 68 g of H_2O_2 gives 22400 mL of O_2 at STP.

Hence, 1000 mL of H_2O_2 solution will give

$$= \frac{22400 \times 54.4}{68} \text{ mL of } \text{O}_2 \text{ at STP}$$

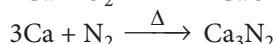
Hence, volume strength of 1.6 M H_2O_2 solution = 17.92

- (i) Atomic hydrogen torch is used industrially to melt refractory materials like tungsten, tantalum etc.
- (ii) It is used to hydrogenate the unsaturated vegetable oil to vanaspati ghee (saturated) in presence of Raney Ni.



- (i) Electronic configuration of H - $1s^1$
Electronic configuration of alkali metals - ns^1
- (ii) $H - 1e^- \rightarrow H^+$ (unipositive ion)
 $Na - 1e^- \rightarrow Na^+$

Calcium burns in air to form calcium oxide and calcium nitride.

$$2\text{Ca} + \text{O}_2 \xrightarrow{\Delta} 2\text{CaO}$$

$$\text{Ca}_3\text{N}_2 + 6\text{H}_2\text{O} \longrightarrow 3\text{Ca}(\text{OH})_2 + 2\text{NH}_3 \quad (\text{A})$$
$$\text{Ca(OH)}_2 + \text{CO}_2 \longrightarrow \underset{(B)}{\text{CaCO}_{3(s)}} + \text{H}_2\text{O}$$

11. (i) Distilled water does not contain salts and all sea animals can only live in salt water. Thus, sea animals can not survive in distilled water.

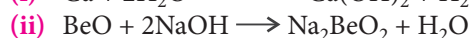
(iii) During severe winter, the temperature of water in the lake keeps on decreasing. Since cold water is heavier, it keeps on going into the interior of the lake while warm water keeps on coming to the surface of the lake. This process continues till the temperature of entire water of lakes becomes 4°C . Since density of water is maximum at 277 K , any further decrease in the temperature will decrease its density. As a result, the temperature of the surface water keeps on decreasing and ultimately freezes.

12. (i) Lithium being lighter than kerosene oil floats on its surface and hence, easily reacts with air.

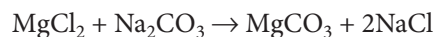
(ii) Alkali metals are highly reactive because of their large size and low ionisation enthalpy. Their reactivity increases on moving down the group from Li to Cs.

(iii) Alkali metals after losing an electron acquire stable electronic configuration of the nearest noble gas and hence, a very large amount of energy is needed to pull out the second electron from stable fully filled electron shell.

(i) $\text{Ca} + 2\text{H}_2\text{O} \xrightarrow{\text{Heat}} \text{Ca(OH)}_2 + \text{H}_2$



(iii) $\text{BaO}_2 + \text{H}_2\text{SO}_4 \longrightarrow \text{BaSO}_4 + \text{H}_2\text{O}_2$



Here, $\text{CaCl}_2 \equiv \text{CaCO}_3 \equiv \text{MgCl}_2$

| | | |
|--------|--------|-------|
| 111 mg | 100 mg | 95 mg |
|--------|--------|-------|

Thus, 111 mg of $\text{CaCl}_2 \equiv 100 \text{ mg of CaCO}_3$

$$\therefore 1 \text{ mg of CaCl}_2 \equiv \frac{100}{111} \text{ mg of CaCO}_3$$

Similarly, 95 mg of $\text{MgCl}_2 \equiv 100 \text{ mg of CaCO}_3$

$$\therefore 1 \text{ mg of MgCl}_2 \equiv \frac{100}{95} \text{ mg of CaCO}_3$$

Total amount of CaCO_3

$$= \frac{100}{111} + \frac{100}{95} = 1.95 \text{ mg}$$

Thus, the amount of CaCO_3 (equivalent to CaCl_2 and MgCl_2) present in 1 litre of water = 1.95 mg

Weight of 1 mL of water = 1 g = 10^3 mg

$$\therefore \text{Weight of 1000 mL of water} = 10^3 \times 10^3$$
$$= 10^6 \text{ mg}$$

Thus, 10^6 mg of water will contain

$$= 1.95 \text{ mg of CaCO}_3$$

$$\therefore \text{Total hardness} = 1.95 \text{ ppm}$$

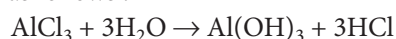
14. (i) Due to smaller size, Li^+ ion has more polarising power than Na^+ ion. Hence, LiCl is more covalent than NaCl .

(ii) Due to bigger size, I^- ion is more polarisable than Cl^- ion. Hence, LiI is more covalent than LiCl and has lower melting point.

(iii) Due to higher charge, Mg^{2+} ion has more polarising power than Na^+ ion. Hence, MgCl_2 is more covalent than NaCl .

15. Both the compounds are salts and they react differently with water.

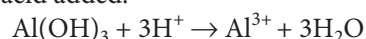
Aluminium (III) chloride or AlCl_3 will react with water as follows :



The reaction is known as hydrolysis.

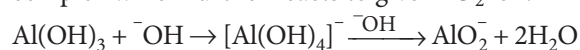
(i) In normal water, both $\text{Al}(\text{OH})_3$ and HCl will be present.

(ii) In acidic water, $\text{Al}(\text{OH})_3$ will be neutralised by the acid added.



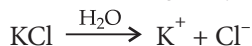
(iii) In alkaline water, HCl will be neutralised by the alkali added.

Also, $\text{Al}(\text{OH})_3$ reacts to form $[\text{Al}(\text{OH})_4]^-$ soluble complex which further reacts to give AlO_2^- ion.



Potassium chloride is a salt of strong acid and strong

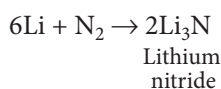
base. It will remain as such under all the conditions and will not undergo any chemical reaction.



16. (i) Smaller the size of the ion, greater is the degree of hydration and lower is the ionic mobility. The size of the alkali metal cations increases down the group hence, degree of hydration decreases down the group and ionic mobility increases in the order :



- (ii) Due to diagonal relationship, Li like Mg forms nitride whereas other alkali metals do not form nitrides so readily. Li reacts with nitrogen of air to form lithium nitride (Li_3N).

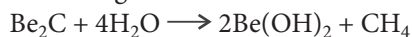


- (iii) Standard electrode potential, $E^\circ_{M^{2+}/M}$ electrode depends upon enthalpy of vaporisation, ionisation enthalpy and enthalpy of hydration. Since the combined effect of these three factors is approximately same for Ca, Sr and Ba, their electrode potentials (E°) are nearly same.

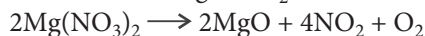
17. Molecular hydrides are classified in three classes :

- (i) Electron deficient hydrides do not have sufficient number of electrons to form normal covalent bonds e.g., B_2H_6 , AlCl_3 .
 (ii) Electron precise compounds have the required number of electrons to form normal covalent bonds e.g., CH_4 , C_2H_6 .
 (iii) Electron rich hydrides have excess electrons which are present as lone pairs e.g., NH_3 , H_2O .

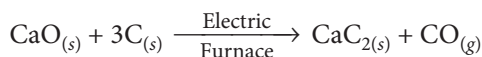
18. (i) Methane gas is evolved.



- (ii) Brown coloured gas NO_2 is evolved.



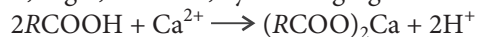
- (iii) Calcium carbide is formed with evolution of carbon monoxide.



19. The distilled water which is free from all soluble minerals is termed as demineralised water. Demineralisation is done by ion exchange resins which are synthetic substances. These are of two types :

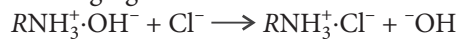
- (i) Cation exchange resins and
 (ii) Anion exchange resins.

The hard water is first passed through a bed of cation exchanger which removes the cations like Na^+ , Mg^{2+} , Ca^{2+} etc., by exchanging with H^+ ions.



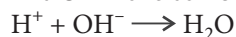
Cation
exchange resin

The water coming from cation exchanger is acidic. This water is then passed through anion exchanger which removes anions like Cl^- , SO_4^{2-} , NO_3^- , etc., by exchanging with OH^- ions.



Anion
exchange
resin

The OH^- ions combine with H^+ ions to form water.

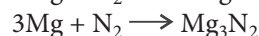


This process gives demineralised water.

20. (i) $2\text{Ca}(\text{NO}_3)_2 \rightarrow 2\text{CaO} + 4\text{NO}_2 + \text{O}_2$

- (ii) $\text{CaO} + \text{SiO}_2 \rightarrow \text{CaSiO}_3$

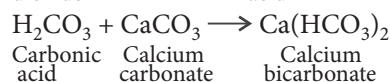
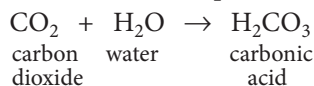
- (iii) $2\text{Mg} + \text{O}_2 \rightarrow 2\text{MgO}$



21. (i) Smaller atomic size causes the electrons to be packed more closely, thereby forming strong metallic bonds. That is why the alkaline earth metals are harder and denser than alkali metals.

- (ii) Beryllium and magnesium are two alkaline earth metals which are kinetically inert towards oxygen because of the formation of an oxide film on their surface. However, powdered beryllium burns brilliantly on ignition in air to give BeO and Be_3N_2 . Magnesium is more electropositive and burns with dazzling brilliance in air to give MgO and Mg_3N_2 .

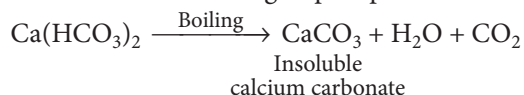
22. In almost every raw water supply, hardness is present as calcium and magnesium bicarbonate often referred to as carbonate hardness or temporary hardness. These compounds result from the action of acidic carbon dioxide laden rainwater on naturally occurring minerals in the earth, such as limestone. For example,



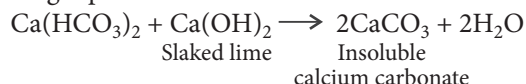
Temporary hardness in water can be easily removed by

- (a) Boiling hard water : On boiling, calcium/magnesium bicarbonate decomposes to give

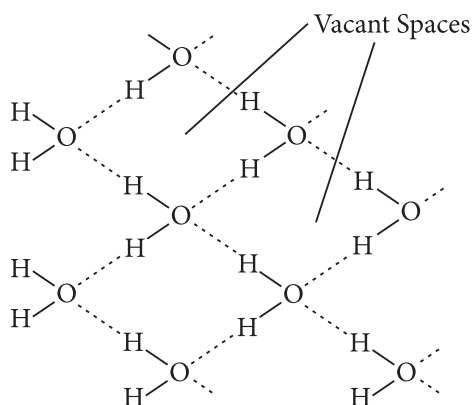
calcium/magnesium carbonate which is insoluble in water and gets precipitated out.



- (b) Adding slaked lime (Clarke's process) : In Clarke's process, slaked lime, $\text{Ca}(\text{OH})_2$ is added to temporary hard water. Insoluble calcium carbonate precipitates out and no longer produces hardness.

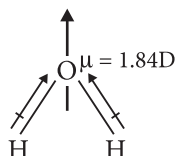


23. (i) The density of ice is lesser than water. This is because ice has open cage like structure with a number of vacant spaces in the crystal lattice. Hence, ice floats over liquid water.



Tetrahedral arrangement of oxygen atoms in ice

- (ii) The values shown by Ria are curiosity to learn and keen observation.
- (iii) The electronegativity of oxygen (3.5) is much higher than that of hydrogen (2.1) and hence the shared pairs of electrons in the O—H bonds are attracted slightly more towards the oxygen atom. As a result, oxygen carries a partial negative charge (δ^-) and hydrogen atoms carry a partial positive charge (δ^+). Since these two dipoles are inclined to each other at an angle of 104.5° therefore, H_2O is a highly polar molecule. Its actual dipole moment is 1.84 D.



24. (i) Tendency to form ionic/covalent compounds :
(a) All common compounds of alkali metals are

generally ionic in nature. Halides and oxides are ionic in nature with the exception of lithium compounds which are generally covalent in nature.

- (b) Alkaline earth metals form ionic oxides and halides except Be which forms covalent compounds.

(ii) Nature of oxides and their solubility in water :

- (a) Alkali metals form oxides, peroxides and superoxides. These oxides are basic in nature and basic character increases down the group. Oxides dissolve in water to give hydroxides. These hydroxides are strong bases.
- (b) Alkaline earth metal oxides are basic in nature but less basic than alkali metal oxides. BeO is amphoteric while other oxides are basic and form sparingly soluble hydroxides.

(iii) Formation of oxosalts :

- (a) Alkali metals form sulphates, carbonates and bicarbonates. (b) Alkaline earth metals form sulphates, carbonates and nitrates.

(iv) Solubility of oxosalts : (a) Oxosalts of alkali metals are generally soluble in water. Solubility increases down the group.

- (b) Carbonates and sulphates of alkaline earth metals become insoluble as we move down the group.

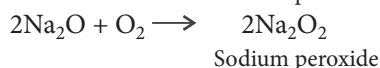
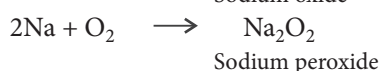
(v) Thermal stability of oxosalts : (a) Oxosalts of alkali metals are thermally stable and stability increases down the group. Li_2CO_3 and Li_2SO_4 decompose on heating.

- (b) Carbonates of alkaline earth metals decompose on heating while their thermal stability increases down the group.

OR

As the element imparts yellow colour in the flame test, it must be sodium.

It reacts with O_2 to form sodium peroxide and sodium oxide.



So, mainly sodium peroxide is formed.

The ionisation enthalpy of sodium is low. When sodium metal or its salt is heated in Bunsen flame, its outermost electron gets excited to higher energy

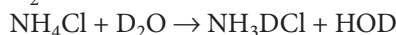
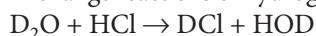
level by absorption of energy. When the excited electron returns to the ground state, it emits the extra energy which falls in yellow region of the visible spectrum. Therefore, sodium imparts yellow colour to the flame.

25. (i) D_2O is prepared by exhaustive or prolonged electrolysis of water (H_2O).

(ii) Physical properties :

- D_2O is a colourless, odourless, tasteless liquid. It has maximum density 1.1073 g mL^{-1} at 11.6°C (Maximum density of water is at 4°C).
- Solubility of salts in heavy water is less than that in ordinary water because it is more viscous than ordinary water.
- Nearly, all physical constants of D_2O are higher than H_2O . It is due to the greater nuclear mass of deuterium atom than H-atom and stronger H-bonding in D_2O than H_2O .

(iii) Exchange reactions of hydrogen with deuterium :



OR

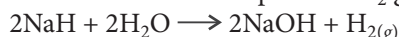
(i) Since the ionic hydride of alkali metal has significant covalent character, therefore, it is LiH. Since LiH is very stable therefore, it is almost unreactive towards O_2 and Cl_2 . It reacts with Al_2Cl_6 to form lithium aluminium hydride



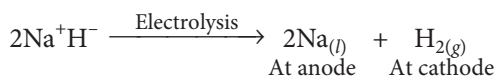
(ii) Sodium reacts with dihydrogen to form sodium hydride which is a crystalline ionic solid.



It reacts with water to produce H_2 gas.



Although Na^+H^- does not conduct electricity in the solid state, but electrolysis of its melt give H_2 gas at anode and Na at cathode.



26. (i) s-block contains only two groups; group 1 (alkali metals) and group 2 (alkaline earth metals).

(ii) The electrode potential *i.e.*, reduction potential of Na (-2.71 V) and K (-2.92 V) is much lower than that of H_2O (-0.83 V) therefore, upon electrolysis, water gets reduced in preference to Na^+ or K^+ ions.

(iii) This is due to abnormal increase in the atomic size of potassium.

(iv) Alkali metals have only one valence electron per metal atom. As a result, the binding energies of alkali metal ions in the close packed metal lattices are weak. Therefore, these are soft and have low melting points.

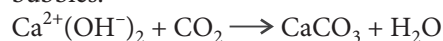
(v) $K + O_2 \rightarrow KO_2$, potassium superoxide is formed.

OR

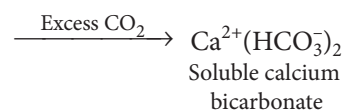
(i) The atomic size of sodium and potassium is larger than that of magnesium and calcium. Thus, the lattice enthalpies of carbonates and hydroxides formed by sodium and potassium are much lower than those of magnesium and calcium. Hence, carbonates and hydroxides of sodium and potassium dissolve readily in water whereas those of calcium and magnesium are only sparingly soluble.

(ii) Both MgO and BeO are useful for lining furnaces because they have high melting points, very low vapour pressures and are good conductors of heat. High melting point (BeO approx. 2500°C , MgO approx. 2800°C), Very low vapour pressures, Chemical inertness and good conduction of heat.

(iii) Solutions of $Ca(OH)_2$ and $Ba(OH)_2$ are called lime water and baryta water respectively, and are used to detect carbon dioxide. When CO_2 is bubbled through these solutions, they become "turbid" or "milky" due to the formation of a suspension of solid particles of $CaCO_3$ or $BaCO_3$. If excess CO_2 is passed through these "milky" solutions then the turbidity disappears as soluble bicarbonates are formed with the excess CO_2 . Baryta water is rather too sensitive as it gives a positive test for CO_2 by exhaling breath on it, whereas with lime water the gas must be blown through the solution as bubbles.



Insoluble
white ppt.



MPP-5 MONTHLY Practice Problems

Class XI



This specially designed column enables students to self analyse their extent of understanding of specified chapters. Give yourself four marks for correct answer and deduct one mark for wrong answer. Self check table given at the end will help you to check your readiness.

Hydrogen and Redox Reactions

Total Marks : 120

Time Taken : 60 Min.

NEET / AIIMS

Only One Option Correct Type

- One of the following is an incorrect statement. Point out the incorrect one
 - Hardness of water depends upon its soap consuming power.
 - Temporary hardness is due to bicarbonates of calcium and magnesium.
 - Permanent hardness is due to soluble sulphates and chlorides of Ca and Mg.
 - Permanent hardness can be removed by boiling water.
- MnO_4^{2-} (1 mol) in neutral aqueous medium disproportionates to
 - $\frac{2}{3}$ mol of MnO_4^- and $\frac{1}{3}$ mol of MnO_2
 - $\frac{1}{3}$ mol of MnO_4^- and $\frac{2}{3}$ mol of MnO_2
 - $\frac{1}{3}$ mol of Mn_2O_7 and $\frac{1}{3}$ mol of MnO_2
 - $\frac{2}{3}$ mol of Mn_2O_7 and $\frac{1}{3}$ mol of MnO_2
- Hydrogen peroxide molecules are
 - diatomic and form HO_2^- ions
 - diatomic and form HO^- ions
 - monoatomic and form H_2^{2-} ions
 - monoatomic and form H^- ions.
- In the reaction between SO_2 and O_3 , the equivalent weight of ozone is
 - the same as its molecular weight
 - half the molecular weight
 - one-third of the molecular weight
 - one-fourth of the molecular weight.
- When the same amount of zinc is treated separately with excess of sulphuric acid and excess of sodium hydroxide, the ratio of volumes of hydrogen evolved is
 - 1 : 1
 - 1 : 2
 - 2 : 1
 - 9 : 4
- Oxidation state of nitrogen is incorrectly given for
 - Compound Oxidation state
 - (a) $[\text{Co}(\text{NH}_3)_5\text{Cl}]\text{Cl}_2$ -3
 - (b) NH_2OH -1
 - (c) $(\text{NH}_4)_2\text{SO}_4$ +2
 - (d) Mg_3N_2 -3
- The reagent commonly used to determine hardness of water titrimetrically is
 - oxalic acid
 - disodium salt of EDTA
 - sodium citrate
 - sodium thiosulphate.
- Which is the best description of the behaviour of bromine in the reaction given below?
$$\text{H}_2\text{O} + \text{Br}_2 \rightarrow \text{HOBr} + \text{HBr}$$
 - Proton acceptor only
 - Both oxidised and reduced
 - Oxidised only
 - Reduced only
- Which of the following can adsorb large volume of hydrogen gas?
 - Colloidal ferric hydroxide
 - Finely divided nickel
 - Colloidal solution of palladium
 - Finely divided platinum

10. If equal volumes of 1 M KMnO_4 and 1 M $\text{K}_2\text{Cr}_2\text{O}_7$ solutions are allowed to oxidise Fe(II) to Fe(III) in acidic medium, then Fe(II) will be oxidised
- more by KMnO_4
 - more by $\text{K}_2\text{Cr}_2\text{O}_7$
 - equal in both the cases
 - can't be determined.
11. Which is not true regarding the following reaction? When chromium hydroxide is treated with H_2O_2 in the presence of NaOH
- $\text{Cr}(\text{OH})_3$ precipitate is converted into soluble sodium chromate
 - the solution acquires yellow colour
 - oxidation state of Cr^{3+} is changed to Cr^{6+}
 - H_2O_2 acts as a reducing agent.
12. In the reaction $\text{S}_8 + 12\text{OH}^- \rightarrow 4\text{S}^{2-} + 2\text{S}_2\text{O}_3^{2-} + 6\text{H}_2\text{O}$ S has undergone oxidation and reduction. Which of the following statement is true?
- In S^{2-} , sulphur has been oxidised and in $\text{S}_2\text{O}_3^{2-}$ sulphur has been reduced.
 - In S^{2-} , sulphur has been reduced and in $\text{S}_2\text{O}_3^{2-}$, sulphur has been oxidised as well as reduced.
 - In both S^{2-} and $\text{S}_2\text{O}_3^{2-}$ ions sulphur has been oxidised.
 - In both S^{2-} and $\text{S}_2\text{O}_3^{2-}$ ions sulphur has been reduced.

Assertion & Reason Type

Directions : In the following questions, a statement of assertion is followed by a statement of reason. Mark the correct choice as:

- If both assertion and reason are true and reason is the correct explanation of assertion.
- If both assertion and reason are true but reason is not the correct explanation of assertion.
- If assertion is true but reason is false.
- If both assertion and reason are false.

13. **Assertion :** Saline hydrides are non-volatile, non-conducting and crystalline solids.
Reason : Saline hydrides are compounds of hydrogen with most of the *p*-block elements.
14. **Assertion :** Oxidation number of carbon in CH_2O is zero.
Reason : CH_2O , formaldehyde, is a covalent compound.
15. **Assertion :** Atomic hydrogen torch produces higher temperatures than oxy hydrogen torch.
Reason : Both oxyhydrogen torch and atomic hydrogen are used for cutting and welding of metals.

JEE MAIN / JEE ADVANCED / PETs

Only One Option Correct Type

16. In which one of the following compounds the oxidation number of oxygen is positive?
- H_2O_2
 - Na_2O_2
 - OF_2
 - H_2O
17. Small quantities of solution of compounds TX, TY and TZ are put into separate test tubes containing X, Y and Z solution. TX does not react with any of these. TY reacts both with X and Z. TZ reacts with X. The decreasing order of ease of oxidation of the anions X^- , Y^- and Z^- is
- Y^- , Z^- , X^-
 - Z^- , X^- , Y^-
 - Y^- , X^- , Z^-
 - X^- , Z^- , Y^-
18. Which oxyacid of chlorine cannot undergo disproportionation?
- HClO
 - HClO_2
 - HClO_3
 - HClO_4
19. Decomposition of H_2O_2 is retarded by
- Acetanilide
 - Urea
 - H_3PO_4
 - all of these.

More than One Options Correct Type

20. When Cl_2 is passed through hot NaOH, oxidation number of Cl changes from
- 1 to 0
 - 0 to -1
 - 0 to +7
 - 0 to +5
21. Which of the following statements is correct regarding the conversion of metal into metallic hydride?
- The density of metallic hydride is less than that of parent metal.
 - The crystal lattice expands through the inclusion of hydride.
 - These are readily decomposed by water liberating H_2 and act as powerful reducing agents.
 - None of these.
22. The equation for a reaction is shown below.
 $2\text{MnO}_4^- + 5\text{H}_2\text{O}_2 + 6\text{H}^+ \rightarrow 2\text{Mn}^{2+} + 8\text{H}_2\text{O} + 5\text{O}_2$
 Which of the following statements about this reaction are correct?
- Hydrogen ions are oxidised to water.
 - Hydrogen peroxide is oxidised to oxygen.
 - The oxidation number of manganese changes by 6.
 - Hydrogen peroxide is reduced to water.

23. Which of the following reactions do not form gaseous product?

- (a) $\text{PbO}_2 + \text{H}_2\text{O}_2$ (b) $\text{PbS} + \text{H}_2\text{O}_2$
(c) $\text{Cl}_2 + \text{H}_2\text{O}_2$ (d) $\text{H}_2\text{S} + \text{H}_2\text{O}_2$

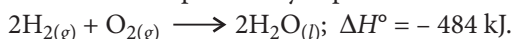
Integer Answer Type

24. When ammonium nitrate is gently heated, an oxide of nitrogen is formed. The oxidation state of nitrogen in oxide is
25. The maximum number of neutrons present in an isotope of hydrogen is
26. In the oxidation of stannous salts with acidified solution of $\text{K}_2\text{Cr}_2\text{O}_7$, the number of moles of Sn^{2+} ions that oxidised by one mole of $\text{Cr}_2\text{O}_7^{2-}$ ion is

Comprehension Type

There are three isotopes of hydrogen : protium or ordinary hydrogen (^1_1H); deuterium or heavy hydrogen (^2_1H or D) and tritium (^3_1H or T). The chemical properties of the three isotopes are similar because they have same electronic configuration. The physical properties of three isotopes are different due to difference in their masses, i.e., isotope effect.

The reaction of hydrogen and oxygen is highly exothermic, and gas mixture that contain as little as 4% by volume hydrogen in oxygen (or in air) are highly flammable and potentially explosive.



27. Dihydrogen on reaction with oxygen gives water and the reaction is
(a) highly exothermic (b) highly endothermic
(c) explosive (d) nuclear.
28. On earth hydrogen is rarely found in its uncombined state because
(a) it is highly inflammable
(b) it combines with oxygen to give water
(c) the earth's gravity is too weak to hold such light molecules
(d) it has three isotopes.

Matrix Match Type

29. Match the entries listed in column I with appropriate entries listed in column II.

Column I

- (A) LiH
(B) BeH_2
(C) CH_4
(D) CaH_2

Column II

- (P) Conducts electricity when melted.
(Q) The concept of hybridisation is applicable
(R) Liberates hydrogen at the anode on electrolysis in molten condition.
(S) Produces hydrogen when dissolved in water
(T) Negative oxidation state of hydrogen atom.

| | A | B | C | D |
|-----|------------|------|---|------------|
| (a) | S, T, P, R | Q, T | Q | P, R, S, T |
| (b) | P, R, S, T | Q, T | Q | P, R, S, T |
| (c) | R, P, S, T | T, Q | Q | P, R, S, T |
| (d) | P, R, S, T | Q, T | Q | P, T, S, R |

30. Match the entries listed in column I with appropriate entries listed in column II.

Column I

- (A) $2\text{H}_2\text{O}_2 \xrightarrow{\Delta} 2\text{H}_2\text{O} + \text{O}_2$
(B) $2\text{NaH} \xrightarrow{\Delta} 2\text{Na} + \text{H}_2$
(C) $\text{V}_2\text{O}_5 + 5\text{Ca} \xrightarrow{\Delta} 2\text{V} + 5\text{CaO}$
(D) $\text{CaCO}_3 \xrightarrow{\Delta} \text{CaO} + \text{CO}_2$

Column II

- (P) Metal displacement reaction
(Q) Disproportionation reaction
(R) Decomposition reaction
(S) Redox reaction

| | A | B | C | D |
|-----|------|------|------|---|
| (a) | Q, S | R, S | P, S | R |
| (b) | R, S | R, Q | P, S | R |
| (c) | Q, S | R, S | P, S | R |
| (d) | P, S | R, S | Q, S | R |



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No. of questions correct
Marks scored in percentage

Check your score! If your score is

| | | |
|--------|--------------------|--|
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| 90-75% | GOOD WORK ! | You can score good in the final exam. |
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Unit 5

HALOALKANES AND HALOARENES ALCOHOLS, PHENOLS AND ETHERS

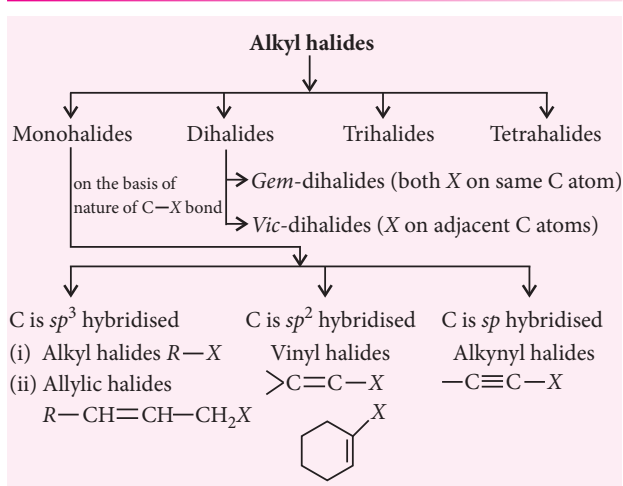
HALOALKANES AND HALOARENES

HALOALKANES

Compounds derived from alkanes by the replacement of one or more hydrogen atoms by corresponding number of halogen atoms (fluorine, chlorine, bromine or iodine) are termed as *haloalkanes*.

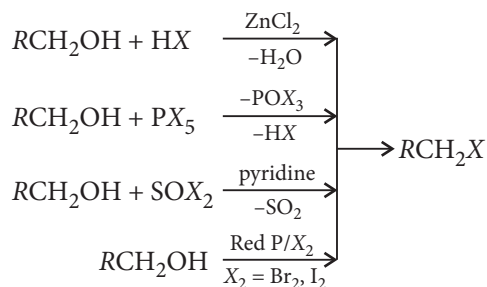
Alkyl halides are represented by general formula $C_nH_{2n+1}X$, where X is the halogen atom.

CLASSIFICATION

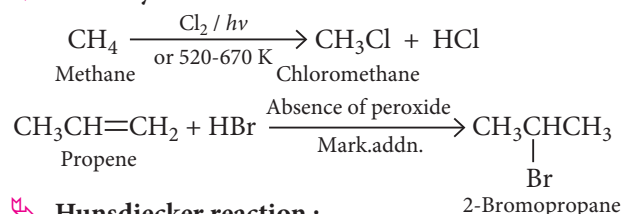


METHODS OF PREPARATION

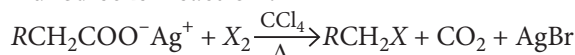
From alcohols :



From hydrocarbons :



Hunsdiecker reaction :



Finkelstein reaction :



Swarts reaction :



PHYSICAL PROPERTIES

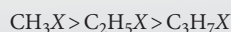
Dipole moment : Haloalkanes are polar compounds and their polarity depends on electronegativity of halogen. Dipole moment of halomethanes are
 $\text{CH}_3\text{Cl} > \text{CH}_3\text{F} > \text{CH}_3\text{Br} > \text{CH}_3\text{I}$
 1.86 D 1.84 D 1.83 D 1.63 D

Density : The density increases with atomic mass of halogen and decreases with increase in size of alkyl group.

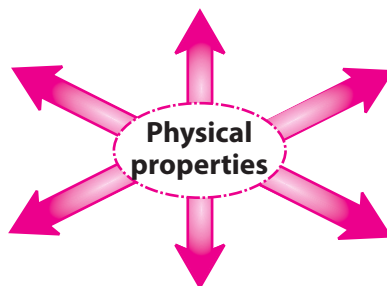
- For same alkyl group, density follows the order



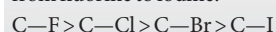
- For same halogen atom, density follows the order



Physical state and smell : Lower members are colourless gases at room temperature, alkyl halides up to C_{18} are colourless sweet smelling liquids while higher members are colourless solids.



Bond strength : Bond strength of carbon-halogen bond decreases with increase in the bond length as we move from fluorine to iodine.



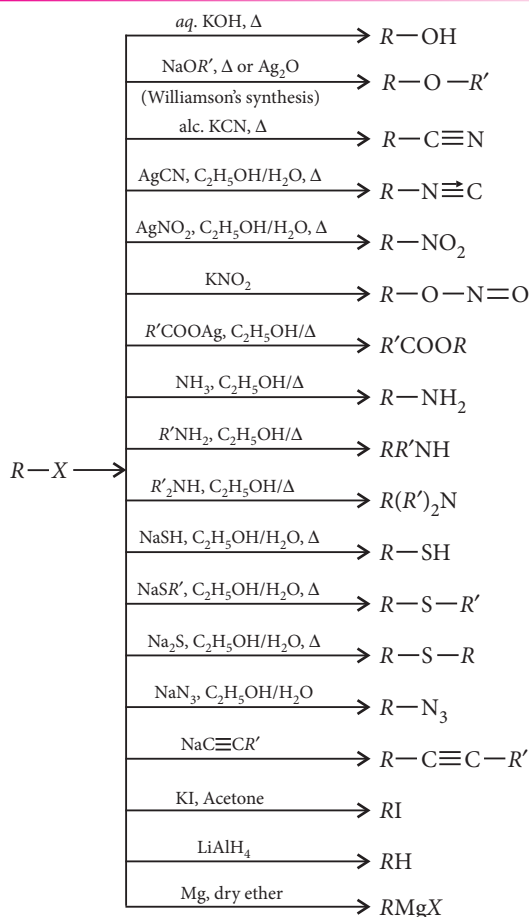
Boiling point : The boiling point increases from $R-F$ to $R-I$



- Boiling point increases with increase in size of alkyl group i.e., $\text{CH}_3X < \text{C}_2\text{H}_5X < \text{C}_3\text{H}_7X$ etc.
- For isomeric alkyl halides, boiling point decreases with branching.

Solubility : Haloalkanes are insoluble in water but soluble in organic solvents.

CHEMICAL PROPERTIES

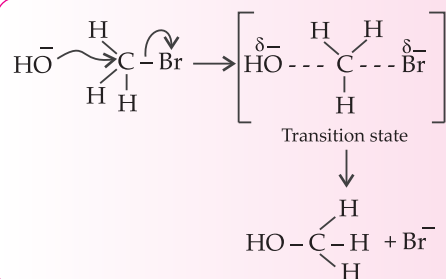
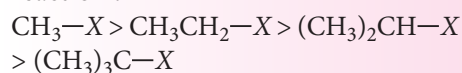


MECHANISM OF SUBSTITUTION REACTION

$\text{S}_{\text{N}}2$ reaction

The mechanism is a one step concerted mechanism in which attack of nucleophile and the displacement of the halide ion take place simultaneously.

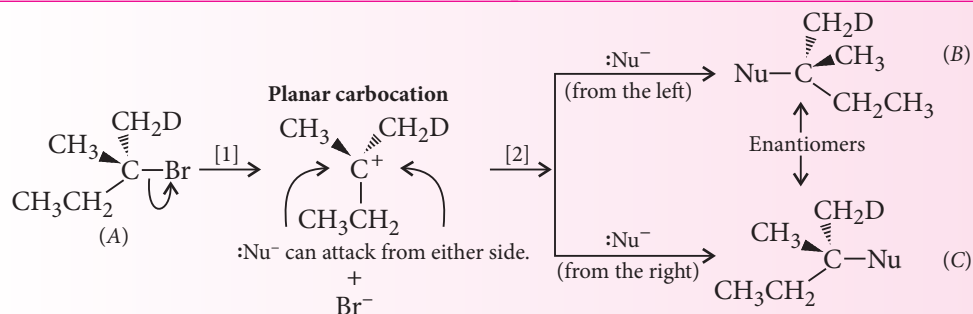
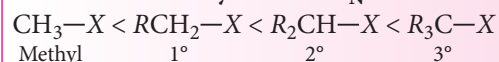
Order of reactivity towards $\text{S}_{\text{N}}2$ reaction :



Rate of $\text{S}_{\text{N}}2$ reaction depends upon the concentration of halide and nucleophile both so, it is called *bimolecular nucleophilic substitution*. $\text{S}_{\text{N}}2$ reaction proceeds through inversion of configuration.

The mechanism involves two steps and rate of reaction depends only upon the concentration of halides because it is only participating in slow or rate determining step.

Order of reactivity towards S_N2 reaction :

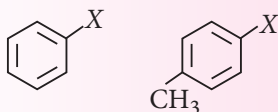


HALOARENES

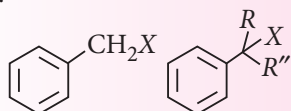
Compounds in which the halogen atom is linked directly to the carbon atom of benzene ring are called aryl halides or haloarenes.

CLASSIFICATION OF HALOARENES

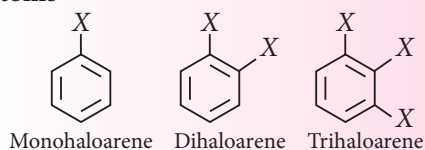
Compounds containing sp² C—X bond
Aryl halides : These are the compounds in which the halogen atom is bonded to sp²-hybridised carbon atom of an aromatic ring.



Compounds containing sp³ C—X bond
Benzylic halides : In these halides, the halogen atom is attached to a benzylic carbon.

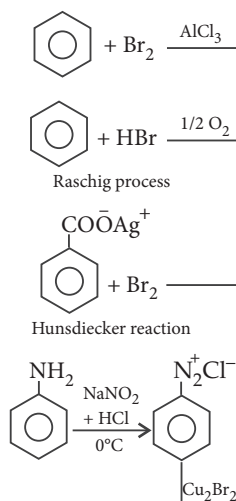


On the basis of number of halogen atoms

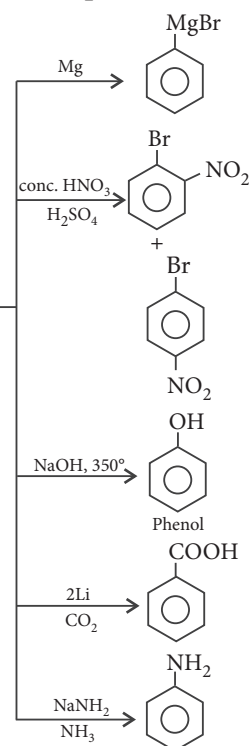


PREPARATION AND PROPERTIES

Preparation



Properties



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PHYSICAL PROPERTIES

Physical state and smell : Haloarenes are generally colourless liquids with pleasant odour or are crystalline solids with characteristic smell.

Physical properties

Boiling point : The boiling points of monohalogen derivatives of benzene are in order

Iodo > Bromo > Chloro > Fluoro

- Boiling and melting points increase as the size of the aryl group increases.

Solubility : Aryl halides are insoluble in water but readily miscible with organic solvents.

Density : Aryl halides are heavier than water. Their density follows the order Aryl iodide > aryl bromide > aryl chloride

Dipole moment : The dipole moment of haloarenes follows the order Fluorobenzene < Chlorobenzene < Bromobenzene \approx Iodobenzene

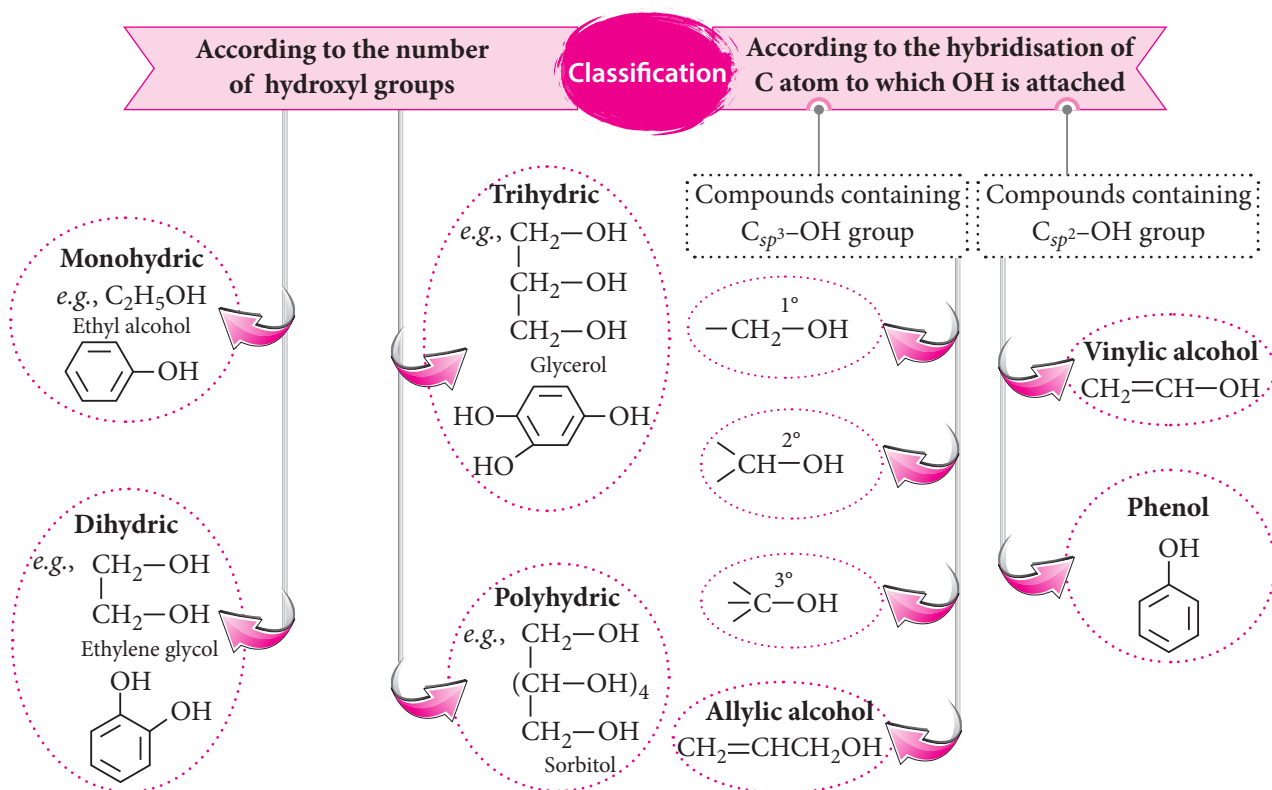
ALCOHOLS, PHENOLS AND ETHERS

ALCOHOLS AND PHENOLS

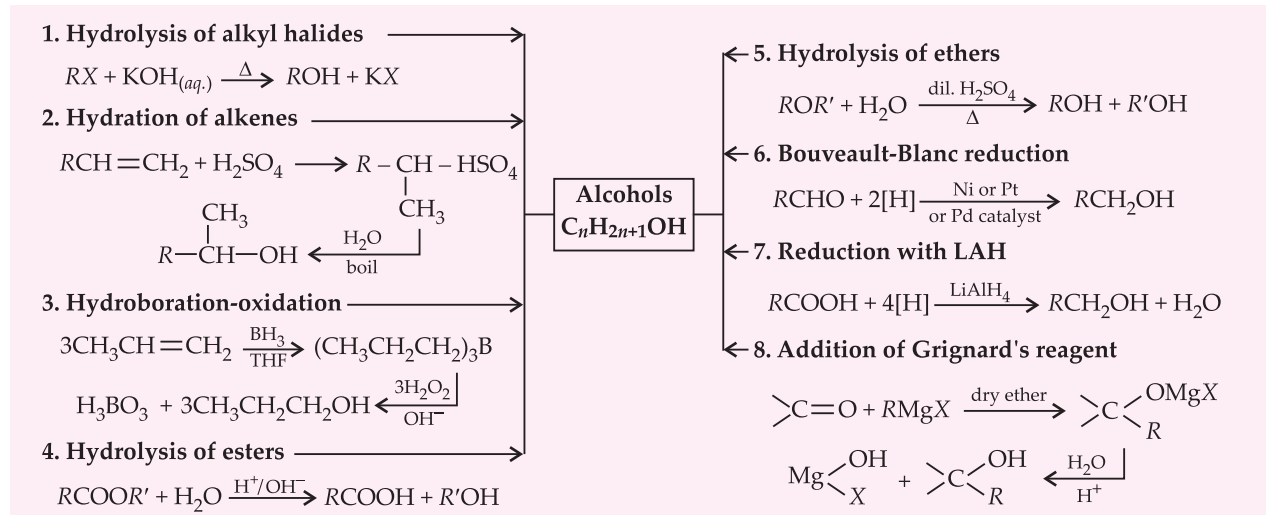
Alcohols and phenols are formed when a hydrogen atom in a hydrocarbon, aliphatic and aromatic respectively, is replaced by – OH group. Compounds in which hydroxy group – OH is directly linked with the aromatic ring are known as phenols.

General formula of alcohols : $C_nH_{2n+2}O$.

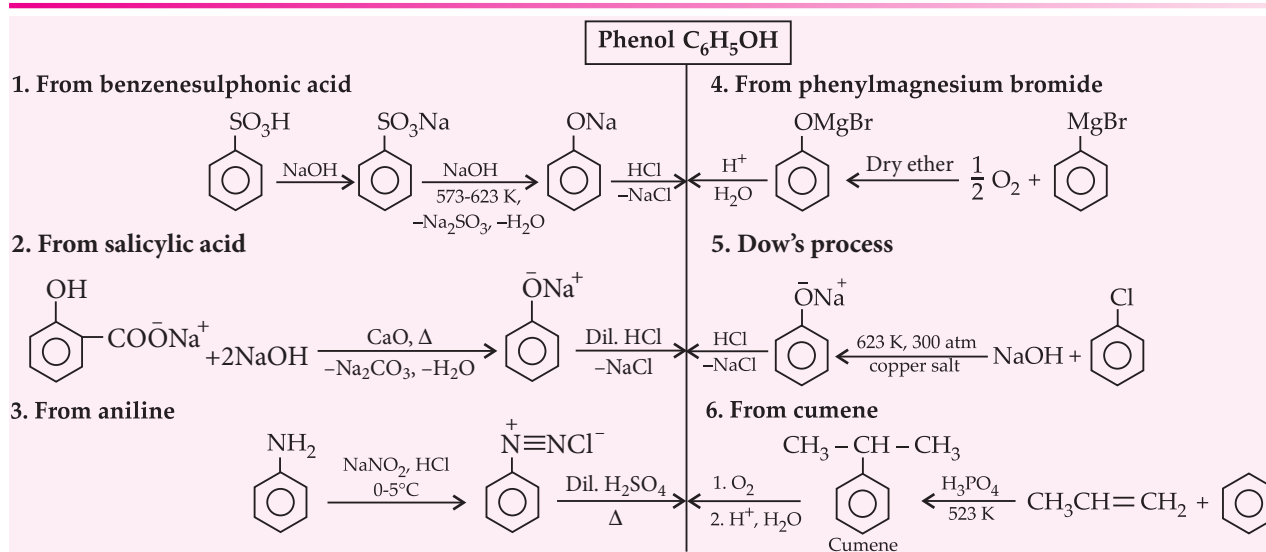
CLASSIFICATION OF ALCOHOLS AND PHENOLS



PREPARATION OF ALCOHOLS



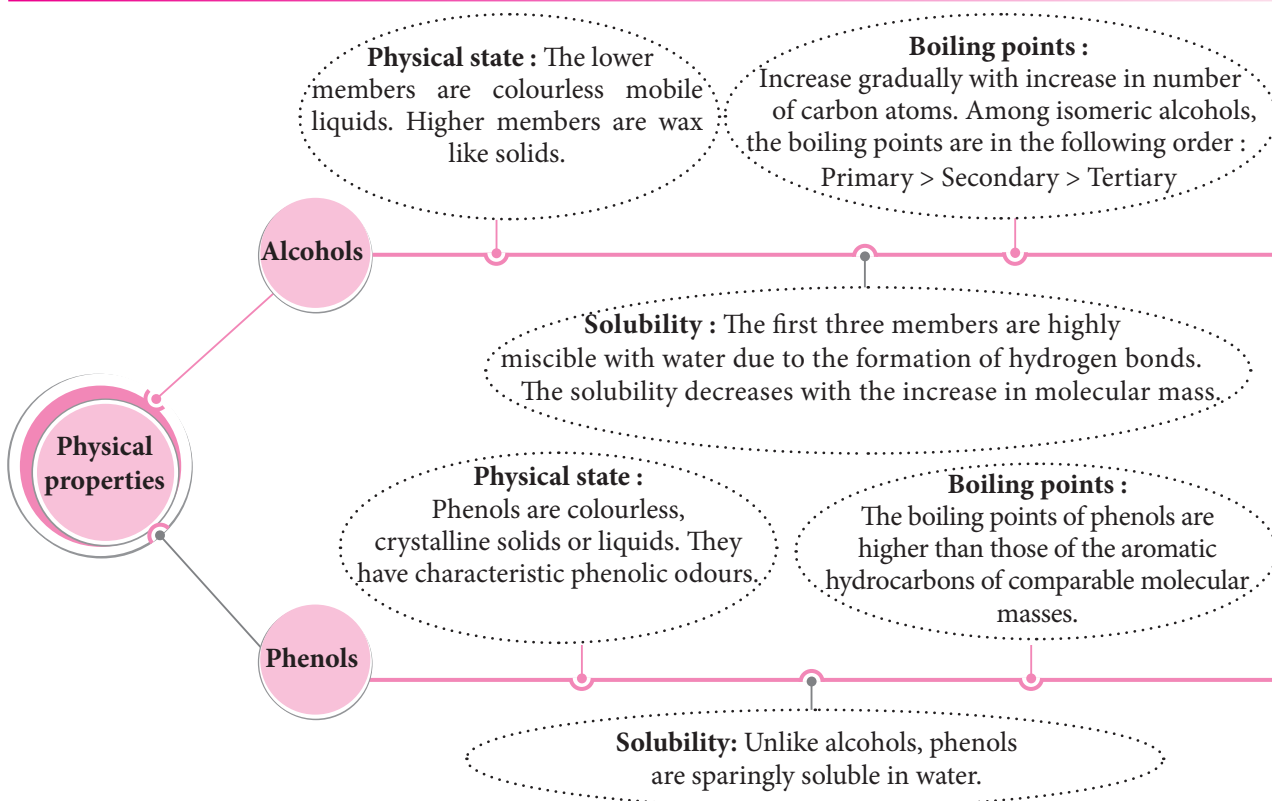
PREPARATION OF PHENOL



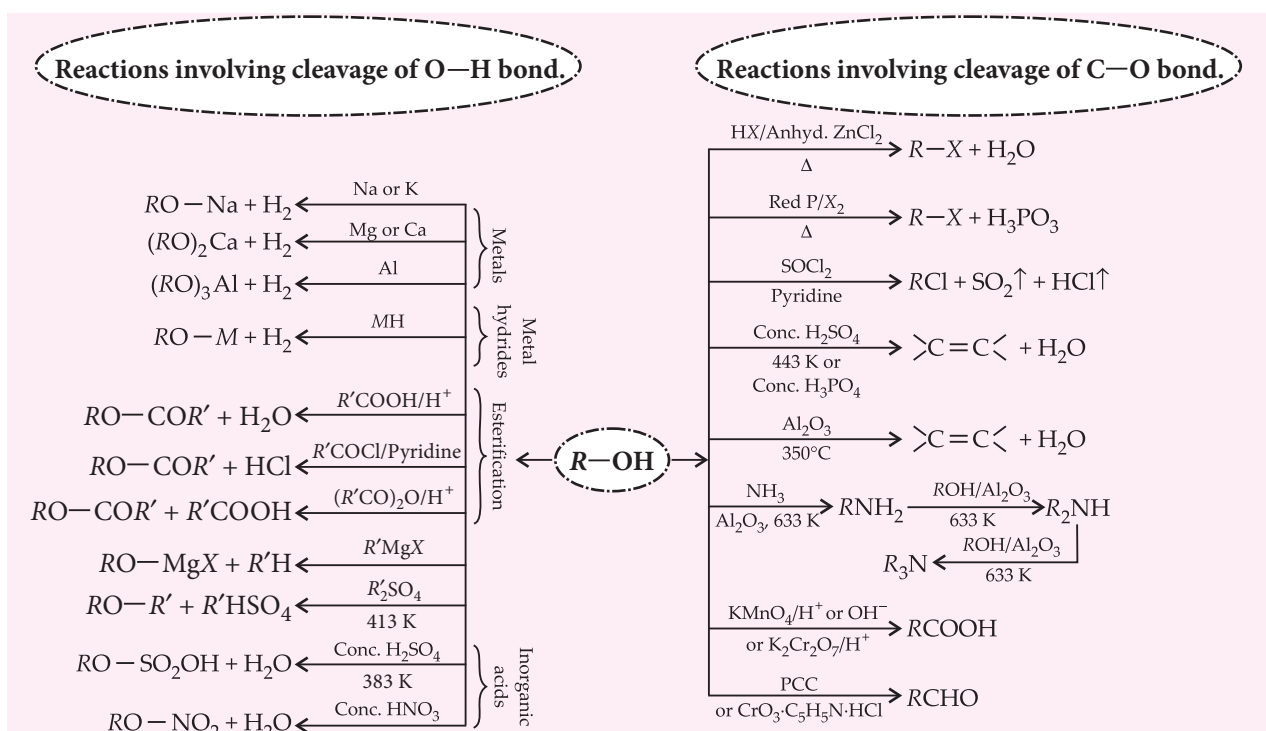
Application of plant phenolics in skin therapy

Phenolic compounds constitute a group of secondary metabolites which have important functions in plants. Besides the beneficial effects on the plant host, phenolic metabolites (polyphenols) exhibit a series of biological properties that influence the human in a health-promoting manner. Evidence suggests that people can benefit from plant phenolics obtained either by the diet or through skin application because, they can alleviate symptoms and inhibit the development of various skin disorders. Due to their natural origin and low toxicity, phenolic compounds are a promising tool in eliminating the causes and effects of skin aging, skin diseases, and skin damage, including wounds and burns. Polyphenols also act protectively and help prevent or attenuate the progression of certain skin disorders, both minor problems e.g., wrinkles, acne or serious, potentially life-threatening diseases such as cancer.

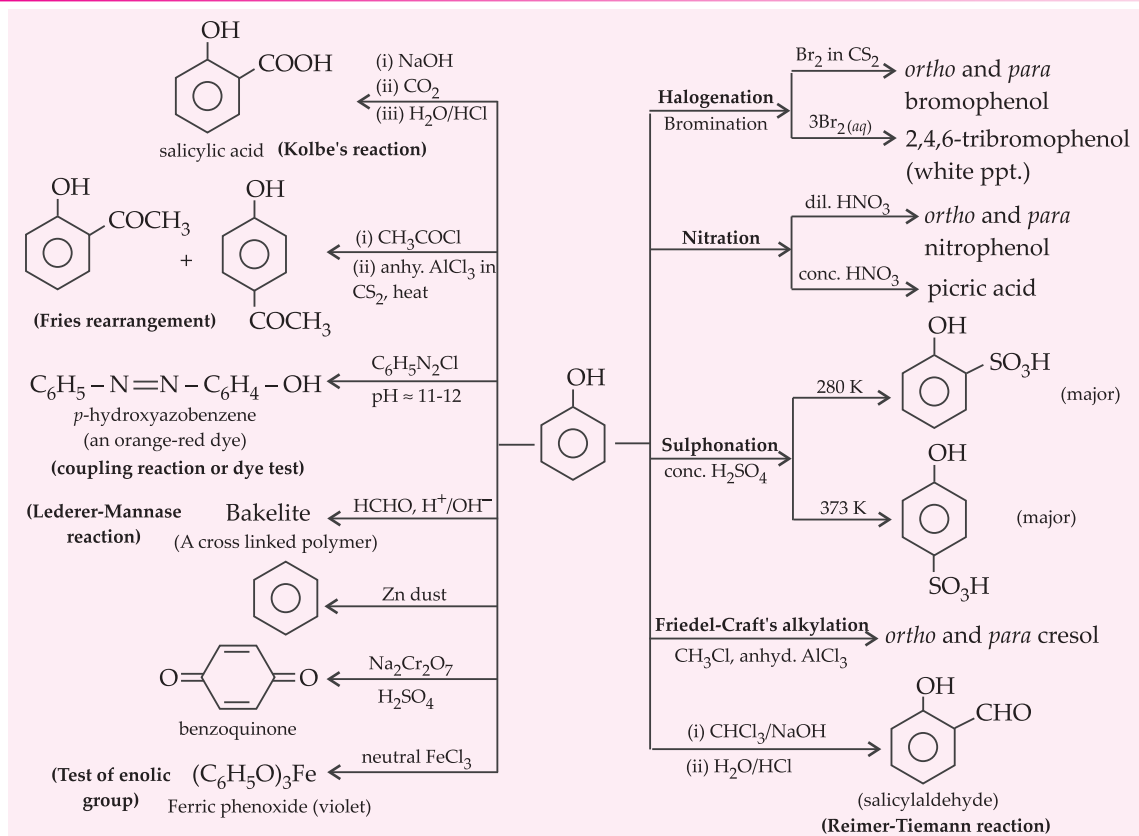
PHYSICAL PROPERTIES OF ALCOHOLS AND PHENOLS



CHEMICAL PROPERTIES OF ALCOHOLS



CHEMICAL PROPERTIES OF PHENOL



ETHERS

Substitution of a hydrogen atom in a hydrocarbon by an alkoxy or aryloxy group (R - O/Ar - O) yields 'ethers' having general formula C_nH_{2n+2}O (n > 1).

CLASSIFICATION OF ETHERS

Classification

- Simple or symmetrical:** Having same R attached to O atom
e.g., C₂H₅OC₂H₅
- Mixed or unsymmetrical:** Two R groups are different
e.g., C₂H₅OC₂H₅
- Aliphatic ethers:** R and R' are both alkyl groups.
e.g., CH₃-O-CH₂CH₃
- Aromatic ethers:** Either one or both R and R' are aryl groups.
e.g., C₆H₅-O-CH₃

ISOMERISM

Isomerism

Functional

- CH₃-O-CH₃
Dimethyl ether
- CH₃-CH₂-OH
Ethyl alcohol

Chain

- CH₃-O-C₅H₁₁
Methoxy pentane
- CH₃-O-CH₂-CH(CH₃)-CH₂-CH₃
1-Methoxy-2-methylbutane

Metamerism

Attachment of different alkyl groups.

- CH₃CH₂OCH₂CH₃
- CH₃OCH₂CH₂CH₃
- CH₃-O-CH(CH₃)-CH₃

PHYSICAL PROPERTIES

Physical properties

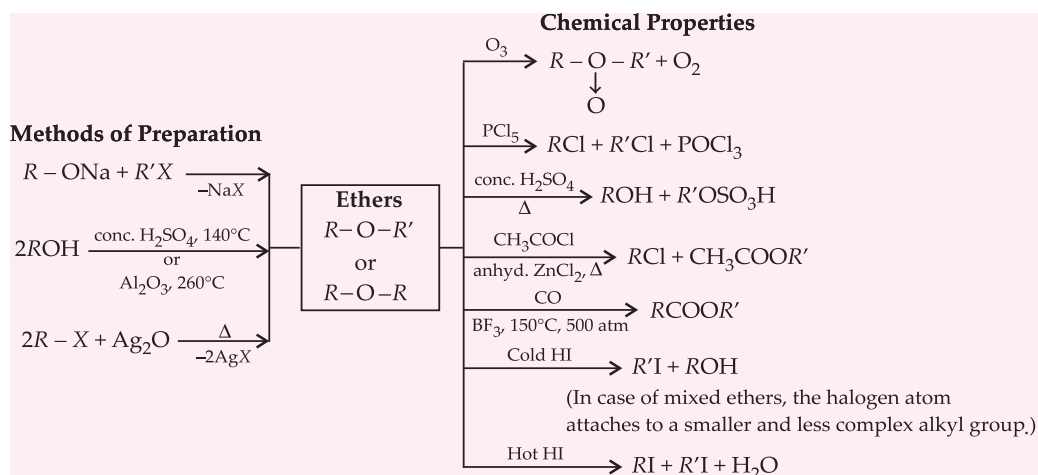
Physical state : Dimethyl ether and ethyl methyl ether are exceptionally gases at room temperature whereas all other ethers are colourless liquids with characteristic ethereal smell.

Solubility : Ethers are soluble in water to a certain extent due to hydrogen bonding. However, solubility decreases with increase of molecular mass *i.e.*, increase in the hydrocarbon part.

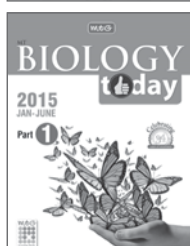
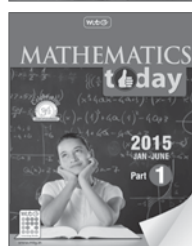
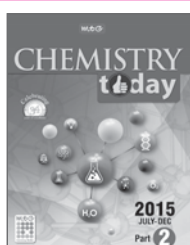
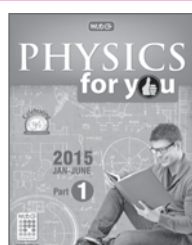
Boiling points : Ethers have lower boiling points than isomeric alcohols due to their inability to form hydrogen bonds and get associated.

Dipole moment : Ethers are polar in nature with a dipole moment varying from 1.15 D to 1.30 D. Since ethers have a bent structure, the polarities of two C—O bonds do not cancel each other.

PREPARATION AND PROPERTIES



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Nearly all properties of matter can be explained in terms of atoms consisting of electrons, protons and neutrons and the various models given to describe the structure of atom are based on classical, quantum and wave mechanical concepts.

Apart from the convenience of being able to identify a given transformation by a simple name and assign credit to specific individual(s) the designation of a name reaction implies a high standard of utility, generality or uniqueness.

- Atoms are uniform spheres of positive electricity in which electrons are embedded.
- Stability of atom is due to the balance between the repulsive forces between the electrons and their attraction towards the centre of the positive charge.

- **Drawbacks**
- Unable to explain the results of scattering experiment.

- **Key points**
- Tiny, very dense, positive nucleus surrounded by diffused electron cloud.
- Electrons move around the nucleus with high speed in a circular path called 'orbit'.
- Radius of nucleus is given by $R = R_0 \sqrt[3]{A}$ cm where R = Radius of nucleus, $R_0 = 1.33 \times 10^{-13}$ cm, A = Mass number
- Volume of nucleus $= 10^{-15} \times \text{Volume of atom}$

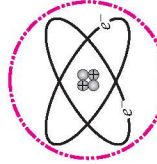
- **Drawbacks**
- Unable to explain stability of atom.
- Unable to explain the line spectra of elements.
- Unable to describe distribution of electrons and energies of electrons.

- **Key points**
- Electrons move around the nucleus in circular orbits of fixed energy and size.
- An electron can jump between these orbits by absorbing or emitting energy.
- The energy difference between two states is given by, $\Delta E = E_2 - E_1$
- It explains the stability of atom and the line spectrum of hydrogen.

- **Key points**
- An atomic orbital is the wave function (Ψ) for an electron in an atom and Ψ^2 (probability density) gives the probability of finding an electron around the nucleus.
- It is based on
 - de Broglie relation: $\lambda = \frac{h}{mv}$
 - Heisenberg's uncertainty principle: Product of uncertainty in the position (Δx) and uncertainty in the momentum (Δp) is always constant. $\Delta x \cdot \Delta p \geq \frac{h}{4\pi}$

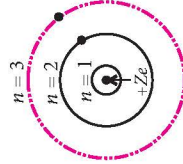


Thomson atomic model or plum pudding model by J.J. Thomson, 1898



Rutherford's Atomic Model, 1911

- Important Terms**
- Atomic number (Z) = No. of protons = No. of electrons in a neutral atom
 - Mass number (A) = No. of protons (Z) + No. of neutrons (n)
 - *Isobars* have different atomic numbers but same mass numbers.
 - *Isotopes* have same atomic number but different mass numbers.



Bohr's atomic model or quantized shell model, 1913

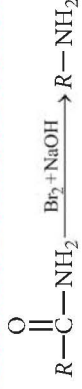
- For hydrogen and hydrogen like particles**
- Energy (E_n) = $\frac{-1312 Z^2}{n^2}$ kJ/mol
 - Radius (r_n) = $\frac{0.529 n^2}{Z}$ Å
 - Speed (v_n) = $\frac{2.18 \times 10^8}{n} \times Z$ cm/sec

- Drawbacks**
- Unable to explain the spectra of multielectron atoms.
 - Unable to explain fine spectra of hydrogen.
 - Unable to explain Zeeman and Stark effects.



Quantum Mechanical Model

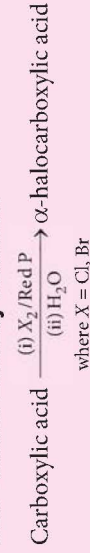
Hoffmann Bromamide Degradation Reaction
Aliphatic/Aromatic amide $\xrightarrow{\text{Br}_2 + \text{NaOH}}$ 1° amine



Hoffmann Mustard Oil Reaction



Hell-Volhard-Zelinsky Reaction



Rosenmund Reduction



Sandmeyer's Reaction



Schmidt Reaction



Stephen Reaction



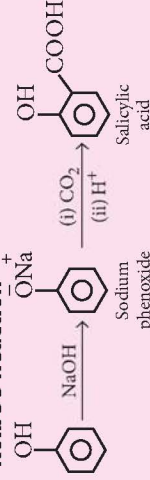
Williamson Synthesis



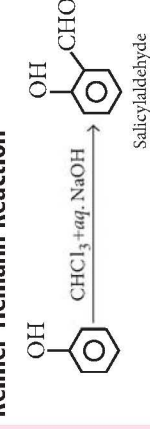
Wurtz-Fittig Reaction



Kolbe's Reaction

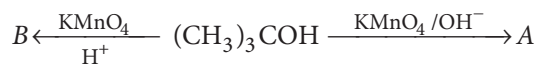


Reimer Tiemann Reaction



SPEED PRACTICE

1. Identify A and B in the given reactions :



- (a) A and B both are $(\text{CH}_3)_2\text{C}=\text{CH}_2$
 (b) A and B both are $(\text{CH}_3)_2\text{CO} + \text{CH}_2\text{O}$
 (c) A is $(\text{CH}_3)_3\text{COH}$, while B is $(\text{CH}_3)_2\text{C}=\text{CH}_2$ or $(\text{CH}_3)_2\text{CO}$
 (d) A and B both are $(\text{CH}_3)_3\text{COH}$, i.e., there is no reaction

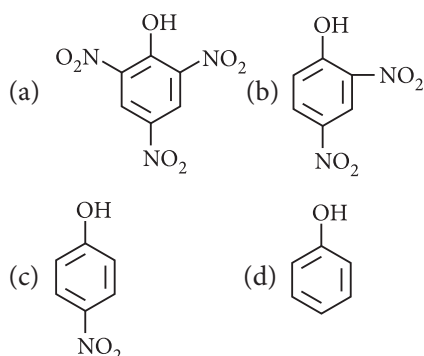
2. In $\text{S}_{\text{N}}2$ reactions, the correct order of reactivity for the following compounds :

CH_3Cl , $\text{CH}_3\text{CH}_2\text{Cl}$, $(\text{CH}_3)_2\text{CHCl}$ and $(\text{CH}_3)_3\text{CCl}$ is

- (a) $(\text{CH}_3)_2\text{CHCl} > \text{CH}_3\text{CH}_2\text{Cl} > \text{CH}_3\text{Cl} > (\text{CH}_3)_3\text{CCl}$
 (b) $\text{CH}_3\text{Cl} > (\text{CH}_3)_2\text{CHCl} > \text{CH}_3\text{CH}_2\text{Cl} > (\text{CH}_3)_3\text{CCl}$
 (c) $\text{CH}_3\text{Cl} > \text{CH}_3\text{CH}_2\text{Cl} > (\text{CH}_3)_2\text{CHCl} > (\text{CH}_3)_3\text{CCl}$
 (d) $\text{CH}_3\text{CH}_2\text{Cl} > \text{CH}_3\text{Cl} > (\text{CH}_3)_2\text{CHCl} > (\text{CH}_3)_3\text{CCl}$

(JEE Main 2014)

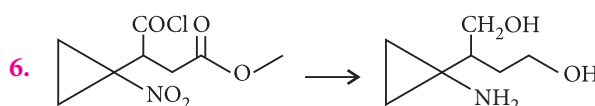
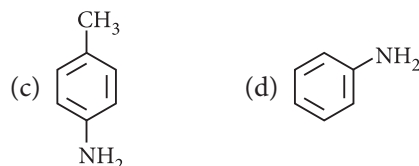
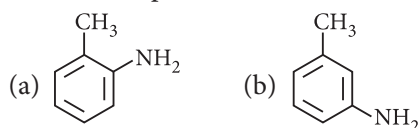
3. Which of the following compounds will react with 5% solution of NaHCO_3 ?



4. The etheral linkage ($-\text{C}-\text{O}-\text{C}-$) is cleaved by

- (a) HBr (b) HNO_3
 (c) both of these (d) none of these.

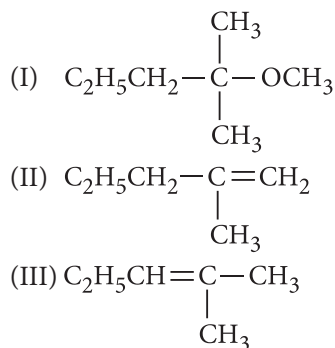
5. Which of the following compounds is the major product when o-chlorotoluene reacts with sodamide in presence of ammonia?



The above reaction can be achieved by

- (a) $\text{H}_2\text{N}-\text{NH}_2/\text{KOH}$ (b) NaBH_4
 (c) $\text{H}_2/\text{Pd}-\text{C}$ (d) Al_2O_3

7. 2-Chloro-2-methylpentane on reaction with sodium methoxide in methanol yields



- (a) all of these (b) I and III
 (c) III only (d) I and II (JEE Main 2016)

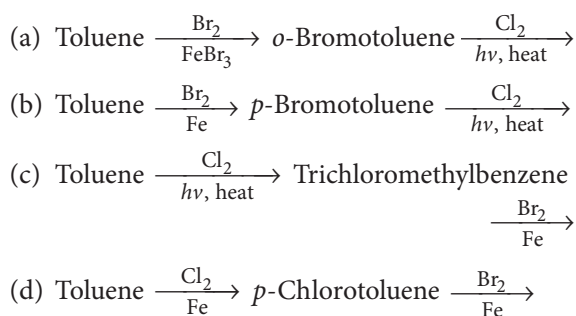
8. Phenols are less reactive than alcohols in reactions involving C—O fission. This is due to

- (a) greater acidity of phenols than alcohols
 (b) less acidity of phenols than alcohols
 (c) C—O bond in phenols becomes weaker due to resonance stabilisation.
 (d) C—O bond in phenols gets double bond character due to resonance.

9. The most suitable reagent for the conversion of $\text{R}-\text{CH}_2-\text{OH} \rightarrow \text{R}-\text{CHO}$ is

- (a) PCC (Pyridinium chlorochromate)
 (b) KMnO_4 (c) $\text{K}_2\text{Cr}_2\text{O}_7$
 (d) CrO_3 (JEE Main 2014)

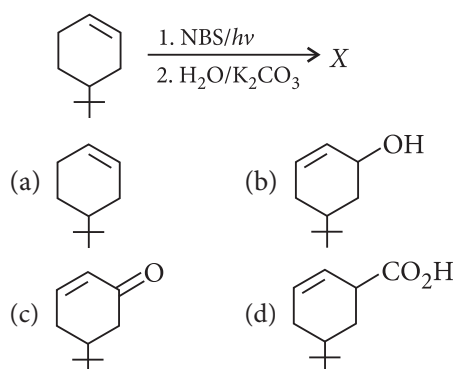
10. Which of the following compounds will give 1-bromo-4-trichloromethylbenzene?



11. *tert*-Butyl ethyl ether cannot be prepared by which of the following reactions?

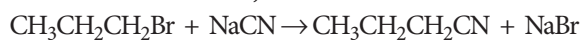
- (a) *tert*-Butanol + Ethanol $\xrightarrow{\text{H}^+}$
- (b) *tert*-Butyl bromide + Sodium ethoxide \rightarrow
- (c) Sodium *tert*-butoxide + Ethyl bromide \rightarrow
- (d) *iso*-Butene + Ethanol $\xrightarrow{\text{H}^+}$

12. The product of the reaction given below is



(JEE Main 2016)

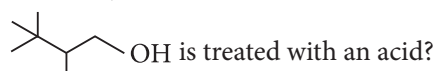
13. Consider the reaction,



This reaction will be the fastest in

- (a) ethanol
- (b) methanol
- (c) *N,N'*-dimethylformamide (DMF)
- (d) water. (NEET Phase-II 2016)

14. Which type of carbocation is/are formed when



- (a) 1° (b) 2°
- (c) 3° (d) All the three.

15. Anisole is treated with HI under two different conditions.



The nature of A to D will be

- (a) A and B are CH_3I and $\text{C}_6\text{H}_5\text{OH}$, while C and D are CH_3OH and $\text{C}_6\text{H}_5\text{I}$
- (b) A and B are CH_3OH and $\text{C}_6\text{H}_5\text{I}$, while C and D are CH_3I and $\text{C}_6\text{H}_5\text{OH}$
- (c) Both A and B as well as both C and D are CH_3I and $\text{C}_6\text{H}_5\text{OH}$
- (d) A and B are CH_3I and $\text{C}_6\text{H}_5\text{OH}$, while there is no reaction in the second case.

16. An ether which is a liquid at room temperature is

- (a) $\text{CH}_3\text{CH}_2\text{OCH}_2\text{CH}_3$
- (b) $\text{CH}_3\text{CH}_2\text{OCH}_3$
- (c) CH_3OCH_3
- (d) none of these.

17. The synthesis of alkyl fluorides is best accomplished by

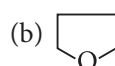
- (a) Finkelstein reaction
- (b) Swart's reaction
- (c) free radical fluorination
- (d) Sandmeyer's reaction. (JEE Main 2015)

18. Reaction of phenol with chloroform in presence of dilute sodium hydroxide finally introduces which one of the following functional groups?

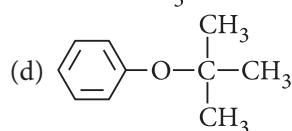
- (a) $-\text{COOH}$ (b) $-\text{CHCl}_2$
- (c) $-\text{CHO}$ (d) $-\text{CH}_2\text{Cl}$ (AIPMT 2015)

19. Which of the following is not likely to form peroxide when exposed to air?

- (a) $\text{CH}_3\text{CH}_2-\text{O}-\text{CH}_2\text{CH}_3$



- (c) $\text{CH}_3-\underset{\text{CH}_3}{\text{CH}}-\text{O}-\text{CH}_3$

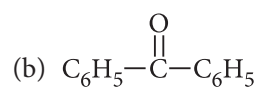
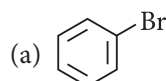


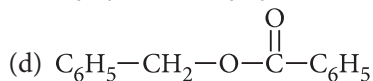
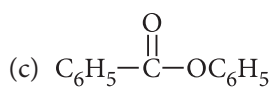
20. Which of the following compounds is most reactive towards acid catalysed dehydration?

- (a) 4-Phenylbutan-1-ol
- (b) 3-Phenylbutan-1-ol
- (c) 2-Phenylbutan-2-ol
- (d) Butan-1-ol



'X' is

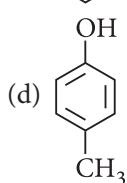
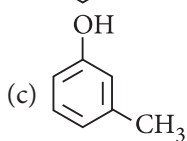
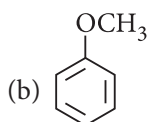
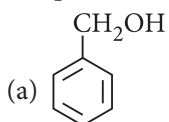




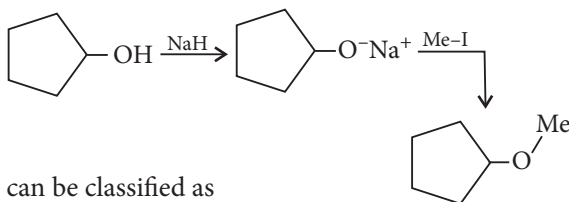
22. The major organic compound formed by the reaction of 1, 1, 1-trichloroethane with silver powder is
 (a) 2-butene (b) acetylene
 (c) ethane (d) 2-butyne.

(JEE Main 2014)

23. An organic aromatic compound having molecular formula $\text{C}_7\text{H}_8\text{O}$ does not give characteristic colour with neutral FeCl_3 but bubbles of hydrogen gas are formed when it is treated with metallic sodium. The compound is



24. The reaction



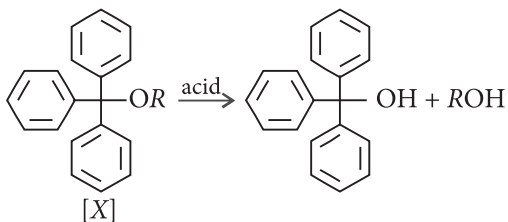
can be classified as

- (a) dehydration reaction
 (b) Williamson alcohol synthesis reaction
 (c) Williamson ether synthesis reaction
 (d) alcohol formation reaction.

(NEET Phase-I 2016)

25. When *cis*-but-2-ene is treated with cold alkaline KMnO_4 , the product is
 (a) racemic mixture of butan-2-ol
 (b) racemic mixture of butane-2, 3-diol
 (c) *meso*-butane-2, 3-diol
 (d) racemic mixture of butane-1, 2-diol.

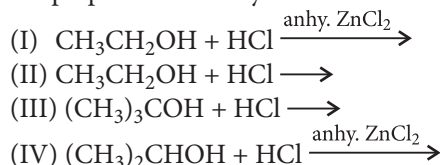
26. The acidic hydrolysis of ether (X) shown below is fastest when



- (a) one phenyl group is replaced by a methyl group
 (b) one phenyl group is replaced by a *para*-methoxyphenyl group
 (c) two phenyl groups are replaced by two *para*-methoxyphenyl groups
 (d) no structural change is made to X.

(JEE Advanced 2014)

27. Which of the following reactions can be used for the preparation of alkyl halides?



- (a) (I) and (II) only
 (b) (IV) only
 (c) (III) and (IV) only
 (d) (I), (III) and (IV) only

(AIPMT 2015)

28. Which of the following reagents cannot give electrophilic aromatic substitution reaction with phenol?

- (a) HCN , NaCN (b) Br_2 , CS_2
 (c) Conc. HNO_3 (d)

29. Conversion of chlorobenzene into phenol involves

- (a) modified $\text{S}_{\text{N}}1$ mechanism
 (b) modified $\text{S}_{\text{N}}2$ mechanism
 (c) both (a) and (b)
 (d) elimination - addition mechanism.

30. In water $\text{H}-\text{O}-\text{H}$, bond angle is 104.5° , but in ethers ($\text{R}-\text{O}-\text{R}$), the $\text{C}-\text{O}-\text{C}$ bond angle is about 110° . The reason is

- (a) positive inductive effect of alkyl groups is more than that of hydrogen
 (b) the alkyl group is polar while hydrogen is not
 (c) distortion caused by the lone pair of oxygen atom is more than compensated by the bulky alkyl groups
 (d) the hybridisation of oxygen atom is different in ethers and in water.

SOLUTIONS

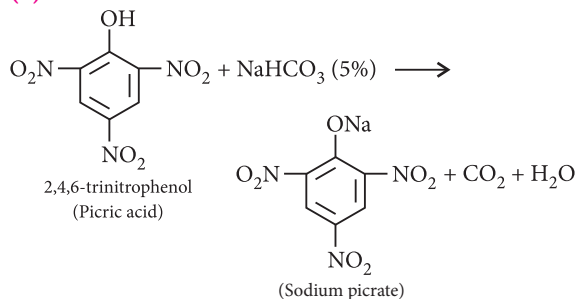
1. (c) : *tert*-Alcohols are not oxidised under alkaline conditions because they do not have any H on C having $-\text{OH}$ group. However, *tert*-alcohols when heated with strong acidic reagents, they undergo dehydration to form alkenes which then undergo oxidation to form ketones.

2. (c): Reactivity in $S_N2 \propto \frac{1}{\text{Steric hindrance}}$

Thus, the correct order of reactivity towards S_N2 reaction is :



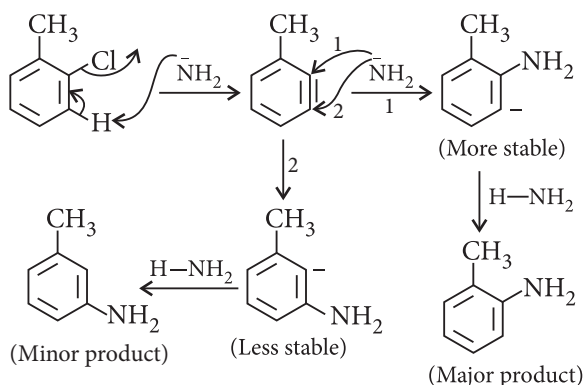
3. (a):



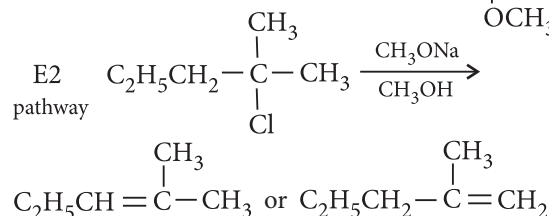
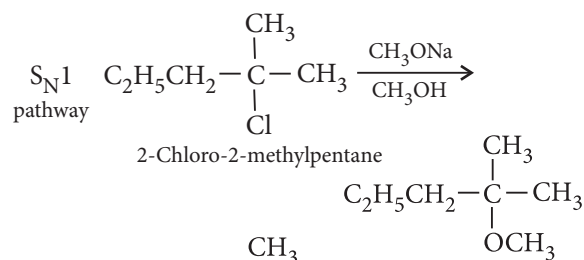
Three $-\text{NO}_2$ groups are electron withdrawing which increase the acidic character to larger extent similar to carboxylic acid, therefore, it reacts with 5% NaHCO_3 .

4. (a): Cleavage of ethers by acid is a nucleophilic substitution reaction which is possible only in case of HI and HBr, but not in HNO_3 .

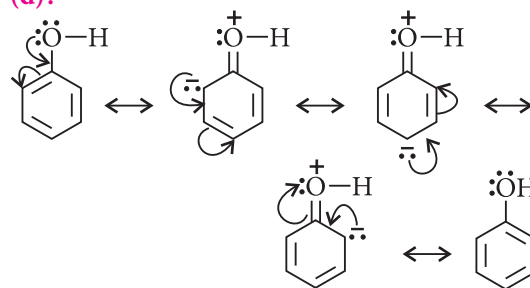
5. (a):



6. (c): (a) is incorrect because $\text{NH}_2-\text{NH}_2/\text{KOH}$ reduces aldehydes and ketones to hydrocarbons.
 (b) is incorrect because ester is not reduced by NaBH_4 .
 (c) is correct. $\text{H}_2/\text{Pd}-\text{C}$ reduces ester into alcohol, acid chloride into alcohol and $-\text{NO}_2$ group into $-\text{NH}_2$ group.
 (d) is incorrect.
7. (a): The reaction can follow S_N1 or $E2$ mechanism thus, all the given three products are possible.

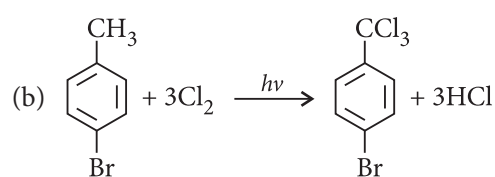
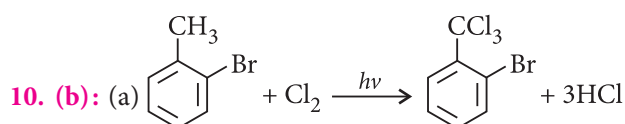


8. (d):

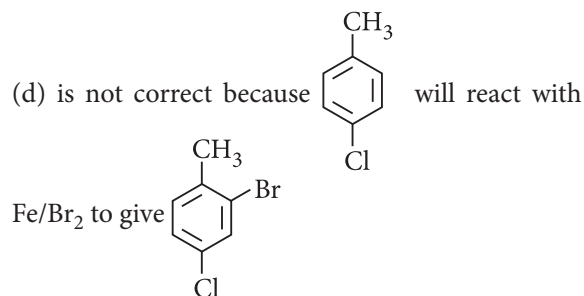


(d) is correct due to double bond character.

9. (a): PCC is highly effective in oxidising 1° alcohols to aldehydes.

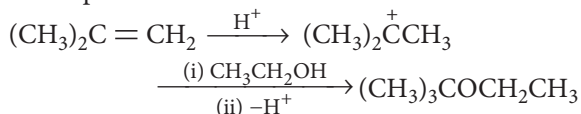


(c) is not correct because $-\text{CCl}_3$ group is *m*-directing.



11. (b): $(\text{CH}_3)_3\text{CBr} + \text{NaOC}_2\text{H}_5$ cannot be applied for synthesising the ether because sodium ethoxide, being a strong base, will preferentially cause elimination reaction.

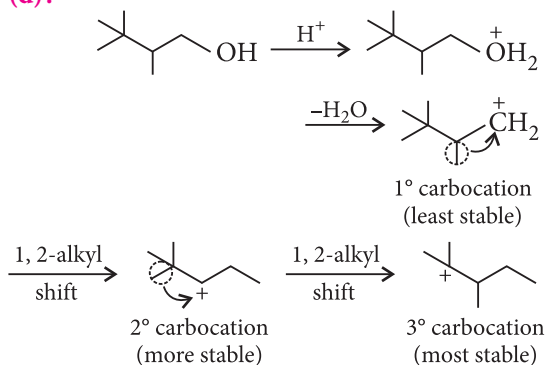
$(\text{CH}_3)_3\text{CBr} \xrightarrow{^-\text{OC}_2\text{H}_5} (\text{CH}_3)_2\text{C}=\text{CH}_2 + \text{HBr}$
 In *iso*-butene + ethanol, *iso*-butene will form *tert*-butyl cation which reacts with ethanol, a nucleophile to form an ether.



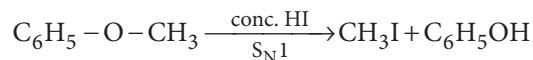
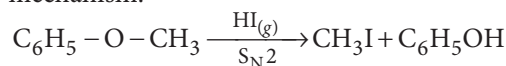
12. (b): The allylic substitution is carried out by heating the alkene with NBS.

13. (c): The reaction,
 $\text{CH}_3\text{CH}_2\text{CH}_2\text{Br} + \text{NaCN} \rightarrow \text{CH}_3\text{CH}_2\text{CH}_2\text{CN} + \text{NaBr}$
 follows $\text{S}_{\text{N}}2$ mechanism which is favoured by polar aprotic solvent *i.e.*, *N,N'*-dimethylformamide (DMF).

14. (d):



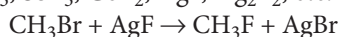
15. (c): Although in both cases products are CH_3I and $\text{C}_6\text{H}_5\text{OH}$; the two reactions follow different mechanism.



Remember that during $\text{S}_{\text{N}}1$ reaction CH_3^+ is formed because it is more stable than C_6H_5^+ .

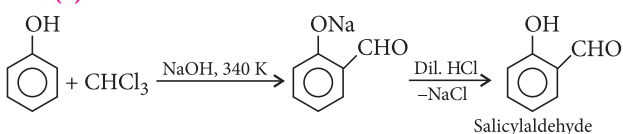
16. (a): Diethyl ether is the simplest ether which is liquid at room temperature.

17. (b): Alkyl fluorides are more conveniently prepared indirectly by heating suitable chloro or bromoalkanes with inorganic fluorides, such as AsF_3 , SbF_3 , CoF_2 , AgF , Hg_2F_2 , etc.

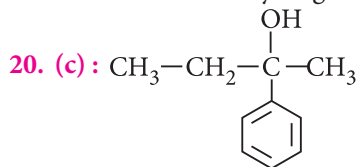


This reaction is called Swart's reaction.

18. (c): This is Reimer-Tiemann reaction.



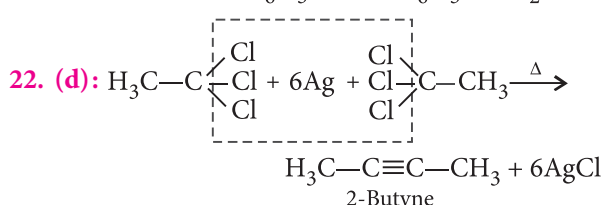
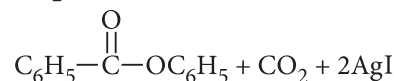
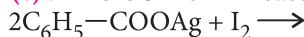
19. (d): $\text{C}_6\text{H}_5-\text{O}-\text{C}(\text{CH}_3)_3$ cannot give peroxide as α -carbon has no hydrogen.



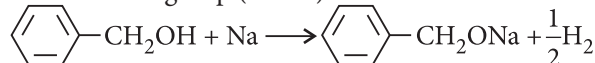
is a 3° - benzylic alcohol,

so the carbocation formed will be most stable.

21. (c): This is Simonini reaction.



23. (a): The compound has no phenolic group, but has an alcoholic group ($-\text{OH}$).



24. (c): Williamson's ether synthesis reaction involves the treatment of sodium alkoxide with a suitable alkyl halide to form an ether.

25. (c): KMnO_4 causes hydroxylation and it is a *syn*-addition.

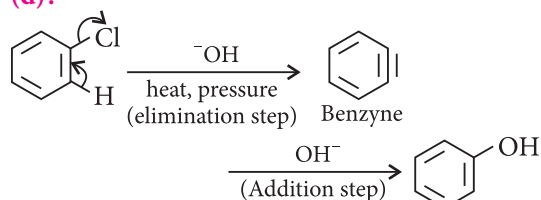
26. (c): Rate of $\text{S}_{\text{N}}1$ reaction is proportional to the stability of carbocation. When two phenyl groups

are replaced by two $\text{MeO}-\text{C}_6\text{H}_4-$ groups, the carbocation formed will be more stable. Hence, the reaction will be fastest.

27. (d): 1° and 2° alcohols react with HCl in presence of anhydrous ZnCl_2 as catalyst while in case of 3° alcohols ZnCl_2 is not required.

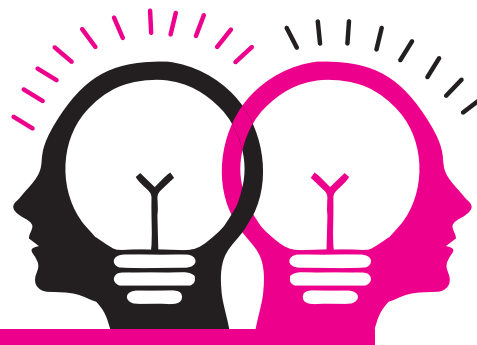
28. (a): Except HCN , NaCN all others readily give electrophilic aromatic substitution reaction with phenol.

29. (d):



30. (c): Bulky groups counter balance the repulsion caused by lone pairs. ♦♦

EXAMINER'S MIND CLASS XII



The questions given in this column have been prepared strictly on the basis of NCERT Chemistry for Class XII.
This year JEE (Main & Advanced)/NEET/AIIMS have drawn their papers heavily from NCERT books.

| | |
|----------------------|---|
| Section - I | Q. 1 to 10 Only One Option Correct Type MCQs. |
| Section - II | Q. 11 to 13 More than One Options Correct Type MCQs. |
| Section - III | Q. 14 to 17 Paragraph Type MCQs having Only One Option Correct. |
| Section - IV | Q. 18 & 19 Matching List Type MCQs having Only One Option Correct. |
| Section - V | Q. 20 to 22 Assertion Reason Type MCQs having Only One Option Correct. Mark the correct choice as : (a) If both assertion and reason are true and reason is the correct explanation of assertion. (b) If both assertion and reason are true but reason is not the correct explanation of assertion. (c) If assertion is true but reason is false. (d) If both assertion and reason are false. |
| Section - VI | Q. 23 to 25 Integer Value Correct Type Questions having Single Digit Integer Answer, ranging from 0 to 9 (both inclusive). |

COORDINATION COMPOUNDS

SECTION - I

Only One Option Correct Type

- According to Werner's theory, the primary valencies of the central metal atom
 - are satisfied by negative ions or neutral molecules
 - are satisfied by negative ions
 - are equal to its coordination number
 - decide the geometry of the complex.
- When one mole of each of the following complex salts is treated with excess of AgNO_3 , which of them gives maximum amount of AgCl ?
 - $[\text{Co}(\text{NH}_3)_6]\text{Cl}_3$
 - $[\text{Co}(\text{NH}_3)_5\text{Cl}]\text{Cl}_2$
 - $[\text{Co}(\text{NH}_3)_4\text{Cl}_2]\text{Cl}$
 - $\text{Na}_2[\text{PtCl}_6]$
- Among $[\text{Fe}(\text{H}_2\text{O})_6]^{3+}$, $[\text{Fe}(\text{CN})_6]^{3-}$, $[\text{Fe}(\text{Cl})_6]^{3-}$ species, the hybridisation state of the Fe atom are, respectively
 - d^2sp^3 , d^2sp^3 , sp^3d^2
 - sp^3d^2 , d^2sp^3 , d^2sp^3
 - sp^3d^2 , d^2sp^3 , sp^3d^2
 - none of these.
- Which of the following ions is paramagnetic?
 - $[\text{Ni}(\text{H}_2\text{O})_6]^{2+}$
 - $[\text{Fe}(\text{CN})_6]^{4-}$
 - $[\text{Ni}(\text{CO})_4]$
 - $[\text{Ni}(\text{CN})_4]^{2-}$
- $[\text{Cr}(\text{H}_2\text{O})_6]\text{Cl}_3$ (At. no. of Cr = 24) has a magnetic moment of 3.83 B.M. The correct distribution of 3d electrons in the central metal of the complex is
 - $3d_{xy}^1, 3d_{yz}^1, 3d_{xz}^1$
 - $3d_{xy}^1, 3d_{yz}^1, 3d_{z^2}^1$
 - $3d_{(x^2-y^2)}^1, 3d_{z^2}^1, 3d_{xz}^1$
 - $3d_{xy}^1, 3d_{(x^2-y^2)}^1, 3d_{yz}^1$
- The geometry of $[\text{Ni}(\text{CO})_4]$ and $[\text{Ni}(\text{PPh}_3)_2\text{Cl}_2]$ are
 - both square planar
 - tetrahedral and square planar respectively
 - both tetrahedral
 - square planar and tetrahedral respectively.
- IUPAC name of $[\text{Pt}(\text{NH}_3)_2\text{Cl}(\text{NO}_2)]$ is
 - platinum diamminechloronitrite
 - chloronitrito-N-ammineplatinum (II)
 - diamminechloridonitrito-N-platinate (II)
 - diamminechloronitrito-N-platinate (II)
- Which of the following will form an inner octahedral complex?

- (a) d^4 (low spin) (b) d^8 (high spin)
 (c) d^6 (low spin) (d) all of these.

9. Which is not true about the coordination compound $[\text{Co}(\text{en})_2\text{Cl}_2]\text{Cl}$?
 (a) It exhibits geometrical isomerism.
 (b) It exhibits optical isomerism.
 (c) It exhibits ionization isomerism.
 (d) It is an octahedral complex.
10. A complex compound of Co^{3+} with molecular formula $\text{CoCl}_x\cdot y\text{NH}_3$ gives a total of 3 ions on dissolving it in water. To satisfy both primary and secondary valencies in this complex, the number of Cl^- ions required is
 (a) one (b) four
 (c) three (d) zero.

SECTION - II

More than One Options Correct Type

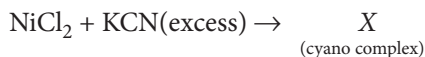
11. Which of the following statements are not correct?
 (a) If $\Delta_o < P$, low spin state is more stable.
 (b) CO is a very weak ligand.
 (c) The colour of a complex depends only on the nature of metal ion.
 (d) Tetrahedral complexes have nearly 50% CFSE value than octahedral complexes.
12. Which of the following statements are false?
 (a) $[\text{Ni}(\text{CO})_4]$ is high spin complex.
 (b) Weak ligands like F^- , Cl^- and OH^- usually form low spin complexes.
 (c) $[\text{FeF}_6]^{3-}$ is a high spin complex.
 (d) Strong ligand like CN^- and NO_2^- , generally form high spin complexes.
13. Which of the following are diamagnetic?
 (a) $[\text{Ni}(\text{H}_2\text{O})_6]^{2+}$ (b) $[\text{Ni}(\text{CN})_4]^{2-}$
 (c) $[\text{Zn}(\text{NH}_3)_4]^{2+}$ (d) $[\text{Co}(\text{NH}_3)_6]^{3+}$

SECTION - III

Paragraph Type

Paragraph for Questions 14 and 15

The coordination number of nickel (II) ion is 4.



14. The IUPAC names for the complexes X and Y are respectively,
 (a) potassium tetracyanonickel(II), potassium tetrachloronickel(II).
 (b) tetracyanonickel(II), tetrachloronickel(II).

- (c) tetracyano potassium nickelate(II), tetra chloro potassium nickelate(III).
 (d) potassium tetracyanonickelate(II), potassium tetrachloronickelate (II).

15. The hybridisation of X and Y are
 (a) sp^3d^2 , dsp^2 (b) dsp^2 , sp^3
 (c) sp^3 , sp^3 (d) sp^3 , dsp^3

Paragraph for Questions 16 and 17

On the basis of elemental analysis, the empirical formula as well as molecular formula of a chromium complex was found to be $\text{CrN}_4\text{H}_{12}\text{Cl}_2\text{Br}$. This complex could be isolated in two isomeric forms. One of these two forms was found to produce a white precipitate on reaction with AgNO_3 solution. The white precipitate was found to be readily soluble in dilute aqueous ammonia. The other isomer forms a yellow precipitate on reaction with AgNO_3 and this yellow precipitate is only partly soluble in concentrated ammonia solution.

16. The two isomeric forms of the complex are
 (a) linkage isomers (b) ionisation isomers
 (c) coordination isomers
 (d) none of these.
17. If we measure the conductivity of aqueous solutions of these two isomers, the conductivity of the isomer forming white ppt with AgNO_3 will be
 (a) more than that of the other forming yellow precipitate
 (b) less than the other forming yellow precipitate
 (c) same as that of the other
 (d) none of the above is correct.

SECTION - IV

Matching List Type

18. Match the entries of List I with appropriate entries of List II and select the correct answer using the code given below the lists :

| List I | | List II | |
|-------------------------|--------------------|-------------------------------|-------------------------|
| (Coordination compound) | | (Uses in medicinal chemistry) | |
| P. | <i>cis</i> -platin | 1. | Removal of excess of Cu |
| Q. | EDTA | 2. | Removal of excess of Fe |
| R. | Desferrioxime B | 3. | Lead poisoning |
| S. | D-penicillamine | 4. | Tumours |
| P | Q | R | S |
| (a) | 1 | 2 | 3 |
| (b) | 2 | 4 | 1 |
| (c) | 3 | 1 | 4 |
| (d) | 4 | 3 | 2 |

19. Match the entries of List I with appropriate entries of List II and select the correct answer using the code given below the lists :

| List I | | List II | |
|--------|--|---------|------------------------|
| P. | $[\text{Co}(\text{NH}_3)_4\text{Cl}_2]^+$ | 1. | Optical isomerism |
| Q. | $\text{cis-}[\text{Co}(\text{en})_2\text{Cl}_2]^+$ | 2. | Ionisation isomerism |
| R. | $[\text{Co}(\text{NH}_3)_5(\text{NO}_2)]\text{Cl}_2$ | 3. | Coordination isomerism |
| S. | $[\text{Co}(\text{NH}_3)_6][\text{Cr}(\text{CN})_6]$ | 4. | Geometrical isomerism |

| | P | Q | R | S |
|-----|---|---|---|---|
| (a) | 1 | 2 | 4 | 3 |
| (b) | 4 | 3 | 2 | 1 |
| (c) | 4 | 2 | 1 | 3 |
| (d) | 4 | 1 | 2 | 3 |

SECTION - V

Assertion Reason Type

20. **Assertion :** As compared to non-chelated complexes, chelated complexes are more stable.

Reason : Labile complexes are the complexes which contain ligands that can be easily replaced by other ligands.

21. **Assertion :** $[\text{CoF}_6]^{3-}$ ion shows magnetic moment corresponding to zero unpaired electrons.

Reason : It undergoes d^2sp^3 hybridisation.

22. **Assertion :** The oxidation number of platinum in Zeise's salt is +4.

Reason : Zeise's salt is non-ionic complex.

SECTION - VI

Integer Value Correct Type

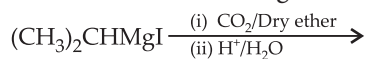
23. The number of unpaired electrons present in $[\text{Fe}(\text{H}_2\text{O})_5\text{NO}]\text{SO}_4$ complex is
24. The coordination number of the element M in the complex $M(\text{DMG})_2$ (where DMG is dimethylglyoxime) is
25. The number of bridged CO groups present in octacarbonyldicobalt (0) is

ALDEHYDES, KETONES AND CARBOXYLIC ACIDS

SECTION - I

Only One Option Correct Type

1. What product will be formed in the given reaction?



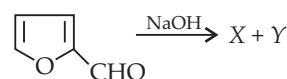
- (a) $(\text{CH}_3)_2\text{C}=\text{O}$ (b) $(\text{CH}_3)_2\text{C}-\underset{\text{OH}}{\underset{\text{OH}}{\text{C}}}(\text{CH}_3)_2$
- (c) $(\text{CH}_3)_2\text{CHCOOH}$ (d) $(\text{CH}_3)_2\text{CHCHO}$
2. Which of the following steps will be required for the conversion of ethanal into butane-1, 3-diol?
- (a) Acylation, reduction
(b) Cross aldol condensation, dehydration
(c) Aldol condensation, oxidation
(d) Aldol condensation, reduction
3. Which reagent is used to convert 2-butanone into propanoic acid?
- (a) NaOH , I_2/H^+ (b) Tollens' reagent
(c) Fehling's solution (d) NaOH , NaI/H^+
4. 2-Butanol is converted into 2-methylbutanoic acid by
- (a) (i) Cu , (ii) HCN , (iii) H_3O^+
(b) (i) HCN , (ii) H_3O^+
(c) (i) PCl_5 , (ii) KCN , (iii) H_3O^+
(d) (i) KCN , (ii) H_3O^+

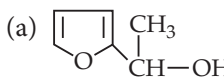
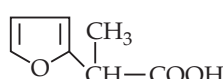
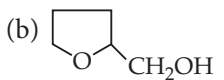

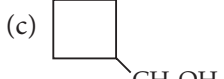

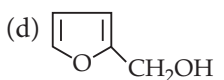

5. A product obtained by the reaction of X with hydroxylamine and on further reduction gives



Hence, the compound X can be

- (a) 2,2-dimethyl-3-pentanone
(b) 3,3-dimethyl-3-butanone
(c) 1-methyl-3-pentanone
(d) diethyl ketone.
6. Identify X and Y .



- (a) X :  Y : 
- (b) X :  Y : 
- (c) X :  Y : 
- (d) X :  Y : 

7. H.V.Z reaction involves the use of P and Cl₂.

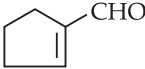
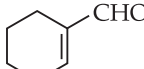
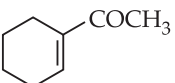
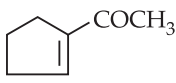


The function of phosphorus is

- (a) to catalyze the reaction
(b) in the formation of PCl₃ which carries out halogenation at the α-carbon atom.
(c) in the formation PCl₃ which converts -COOH into -COCl.
(d) none of these.

8. In the following reaction, the final product is



- (a)  (b) 
(c)  (d) 

9. The correct order of increasing acidic strength is

- (a) Phenol < Ethanol < Chloroacetic acid < Acetic acid
(b) Ethanol < Phenol < Chloroacetic acid < Acetic acid
(c) Ethanol < Phenol < Acetic acid < Chloroacetic acid
(d) Chloroacetic acid < Acetic acid < Phenol < Ethanol

10. Which of the following compounds will give butanone on oxidation with alkaline KMnO₄ solution?

- (a) Butan-1-ol (b) Butan-2-ol
(c) Both (a) and (b) (d) None of these

SECTION - II

More than One Options Correct Type

11. Which of the following products are not correct when CH₃CHO is reduced?

- (a) With HI → CH₃CH₃
(b) With Zn amalgam/HCl → CH₃CH₂OH
(c) With NaBH₄ → CH₃CH₃
(d) With hydrazine and KOH → CH₃CH₃

12. Which of the following conversions can be carried out by Clemmensen reduction?

- (a) Benzaldehyde into benzyl alcohol
(b) Cyclohexanone into cyclohexane
(c) Benzoyl chloride into benzaldehyde
(d) Benzophenone into diphenylmethane

13. An aldehyde can give nucleophilic addition reaction with

- (a) HCN (b) NaHSO₃
(c) R-Mg-X (d) NH₂NH₂

SECTION - III

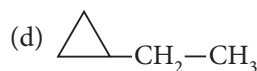
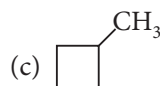
Paragraph Type

Paragraph for Questions 14 and 15

An alkene 'A' (Mol. formula C₅H₁₀) on ozonolysis gives a mixture of two compounds 'B' and 'C'. Compound 'B' gives positive Fehling's test and also forms iodoform on treatment with I₂ and NaOH. Compound 'C' does not give Fehling's test but forms iodoform.

14. Identify the compound 'A'.

- (a) H₃C-CH=CH-CH₂-CH₃
(b) H₃C-CH=C(CH₃)-CH₃



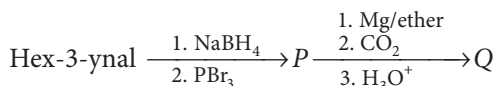
15. Identify the compound 'B' and 'C'.

- (a) 'B' → H₃C-CHO 'C' → H₃CCOCH₃
(b) 'B' → H₃CCOCH₃ 'C' → CH₃-CHO


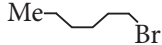

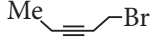


Paragraph for Questions 16 and 17

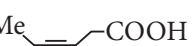

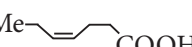
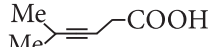
In the following reaction sequence, products P and Q are formed.



16. The structure of the product P is

- (a) Me- (b) Me-
(c) Me- (d) Me-

17. The structure of compound Q is

- (a) Me- (b) Me-
(c) Me- (d) Me-

SECTION - IV

Matching List Type

18. Match the entries of List I with appropriate entries of List II and select the correct answer using the code given below the lists :

| List I (Reactions) | | List II (Reagents) | |
|--------------------------------------|---|---|---|
| P. Benzophenone → Diphenylmethane | | 1. LiAlH_4 | |
| Q. Benzaldehyde → 1-Phenylethanol | | 2. DIBAL—H | |
| R. Cyclohexanone → Cyclohexanol | | 3. Zn(Hg)/ Conc. HCl | |
| S. Phenyl benzoate → Benzaldehyde | | 4. CH_3MgBr | |
| P | Q | R | S |
| (a) 3 | 4 | 1 | 2 |
| (b) 4 | 3 | 2 | 1 |
| (c) 2 | 1 | 4 | 3 |
| (d) 1 | 3 | 4 | 2 |

19. Match the entries of List I with appropriate entries of List II and select the correct answer using the code given below the lists :

| List I (Carbonyl compounds) | | List II (Uses) | |
|--------------------------------|---|--|---|
| P. Formaldehyde | | 1. Perfumery and dye industries | |
| Q. Acetaldehyde | | 2. Bakelite | |
| R. Benzaldehyde | | 3. Odours and flavours | |
| S. Vanillin, Butyraldehyde | | 4. Manufacture of vinyl acetate, ethyl acetate | |
| P | Q | R | S |
| (a) 1 | 2 | 3 | 4 |
| (b) 2 | 3 | 4 | 1 |
| (c) 1 | 3 | 4 | 1 |
| (d) 2 | 4 | 1 | 3 |

SECTION - V

Assertion Reason Type

20. **Assertion** : Acetoacetic ester ($\text{CH}_3\text{COCH}_2\text{COOC}_2\text{H}_5$) contains CH_3CO —group but does not give iodoform test.
Reason : The H-atoms of the $-\text{CH}_3$ group are more acidic than those of $-\text{CH}_2-$ group.

21. **Assertion** : The reaction of aldehydes and ketones with pure HCN is very slow to yield cyanohydrin.

Reason : The above reaction is catalysed by a base and generated cyanide ion being a weaker nucleophile adds to carbonyl compounds to yield, corresponding cyanohydrin.

22. **Assertion** : Boiling points of aldehydes lie in between parent alkanes and corresponding alcohols.

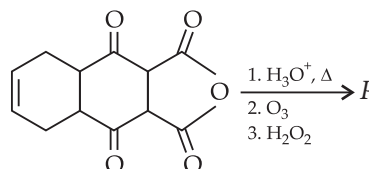
Reason : Aldehydes form intermolecular hydrogen bonds like alcohols.

SECTION - VI

Integer Value Correct Type

23. The number of isomeric ketones having the molecular formula $\text{C}_6\text{H}_{12}\text{O}$ which undergo iodoform test is

24. The total number of carboxylic acid groups in the product *P* is

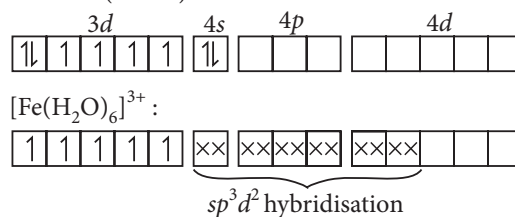


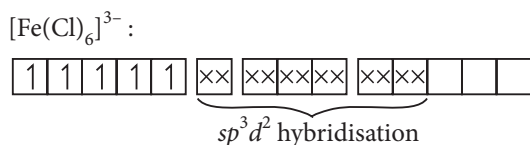
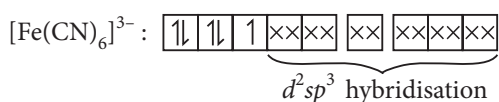
25. The number of reagents which convert aldehydes or ketones to alkanes in the following list is NaBH_4 ; NH_2NH_2 ; KOH ; HI ; red P; H_2 ; Ni ; Zn/Hg, HCl ; LiAlH_4 ; Pt ; acidified KMnO_4 ; alkaline KMnO_4 .

SOLUTIONS

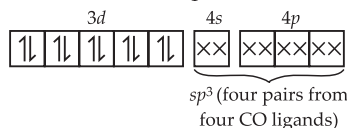
COORDINATION COMPOUNDS

1. (b): According to Werner's theory, the primary valencies of the central metal atom are satisfied by negative ions.
 2. (a): When $[\text{Co}(\text{NH}_3)_6]\text{Cl}_3$ is treated with excess of AgNO_3 then 3 moles of AgCl are obtained, as there are 3 ionisable ions in the complex (present outside the coordination sphere). Compounds (b) and (c) have two and one ionisable Cl^- ions respectively, whereas (d) has none.
 3. (c): Fe atom ($3d^6 4s^2$)

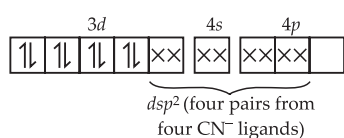




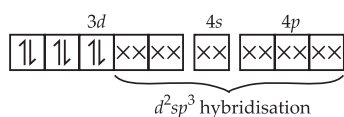
4. (a): In $[\text{Ni}(\text{CO})_4]$,



In $[\text{Ni}(\text{CN})_4]^{2-}$,



In $[\text{Fe}(\text{CN})_6]^{4-}$,

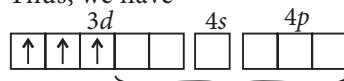


Strong field ligands like CO, CN^- generally result in inner orbital complexes.

In $[\text{Ni}(\text{H}_2\text{O})_6]^{2+}$, H_2O is a weak field ligand, pairing of electrons will not take place.

Hence, $[\text{Ni}(\text{H}_2\text{O})_6]^{2+}$ is paramagnetic in nature.

5. (a): Given : Magnetic moment = 3.83 B.M. Hence, $n = 3$, i.e., there are three unpaired electrons. Thus, we have

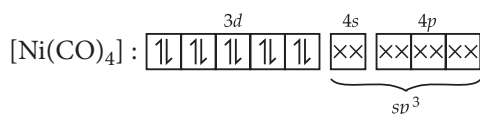


In d^2sp^3 hybridisation, the orbitals taking part are $d_{x^2-y^2}$ and d_{z^2} . Hence, unpaired electrons are present in $3d_{xy}$, $3d_{yz}$, $3d_{xz}$.

6. (c): Oxidation state of Ni in $[\text{Ni}(\text{CO})_4] = 0$

Ni^0 ($Z = 28$): $3d^8 4s^2$

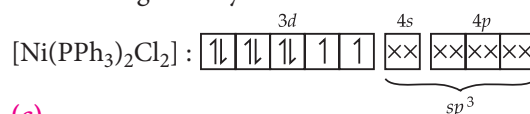
Since CO is a strong field ligand, it forces electrons to pair up and thus sp^3 hybridisation takes place which results in tetrahedral geometry.



In $[\text{Ni}(\text{PPh}_3)_2\text{Cl}_2]$, oxidation state of Ni = +2.

This complex contains weak field ligand (Cl^-) as well as strong field ligand (PPh_3). Weak field ligand favours

tetrahedral geometry and strong field ligand favours square planar geometry. Hence, this compound is borderline between these two geometries. But due to steric effect of two larger PPh_3 ligands less crowded tetrahedral geometry is favoured.

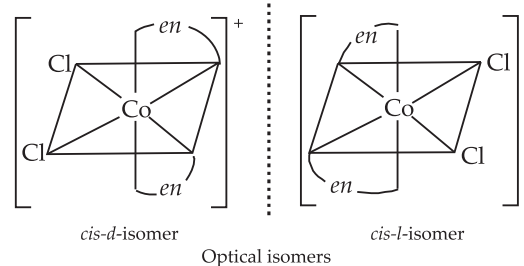
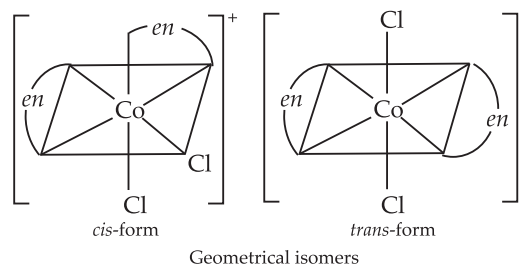


7. (c)

8. (c): In d^6 (low spin), electrons pair up thereby making two empty d -orbitals available for d^2sp^3 hybridisation as in the case of $[\text{Fe}(\text{CN})_6]^{4-}$

9. (c): Ionization isomerism arises when the coordination compounds give different ions in solution, this condition is not satisfied with $[\text{Co}(\text{en})_2\text{Cl}_2]\text{Cl}$.

It is an octahedral complex.



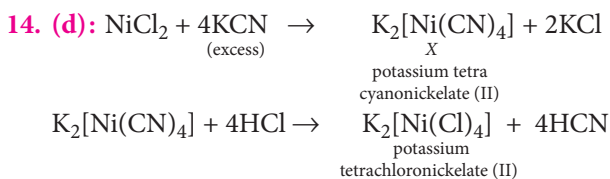
10. (a): As cobalt is present as Co^{3+} and coordination number of cobalt is 6, the molecular formula of compound should be $\text{CoCl}_3 \cdot y\text{NH}_3$. Now, as it gives a total of three ions when dissolved in water, its structural formula must be $[\text{CoCl}(\text{NH}_3)_5]\text{Cl}_2$. $[\text{CoCl}(\text{NH}_3)_5]\text{Cl}_2 \rightleftharpoons [\text{CoCl}(\text{NH}_3)_5]^{2+} + 2\text{Cl}^-$. Thus, only one Cl^- ion is satisfying both primary and secondary valency of Co^{3+} in this compound.

11. (a, b, c): If $P < \Delta_o$, low spin state is more stable. Hence, (a) is wrong. CO is a very strong ligand. Hence, (b) is wrong. The colour of the complex depends not only on the metal ion but also on the nature of the ligand. Hence, (c) is wrong.

12. (a, b, d): Weak field ligands like F^- , Cl^- and OH^- usually form high spin complexes and strong field

ligands like CN^- and NO_2^- usually form low spin complexes. $[\text{Ni}(\text{CO})_4]$ is a low spin complex.

13. (b, c, d)



15. (b): Hybridisation of X $\rightarrow \text{K}_2[\text{Ni}(\text{CN})_4]$ is dsp^2 .
 $Y \rightarrow \text{K}_2[\text{NiCl}_4]$ is sp^3 .

16. (b): In ionization isomers different ions are liberated in the solution. Since the two isomers react differently with AgNO_3 , so they liberate different ion in solution and thus are ionization isomers.

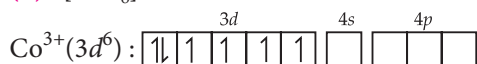
17. (c): The two isomers are ionisation isomers and they may be represented as $[\text{Cr}(\text{NH}_3)_4\text{Cl}_2]\text{Br}$ and $[\text{Cr}(\text{NH}_3)_4\text{BrCl}]\text{Cl}$.
 'A' forms yellow precipitate of AgBr with AgNO_3 .
 'B' forms white precipitate of AgCl with AgNO_3 .
 Since in solution both the isomers produce 2 ions, so their aqueous solutions will show approximately same conductivity.

18. (d)

19. (d)

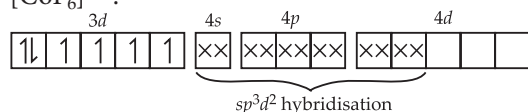
20. (b)

21. (d): $[\text{CoF}_6]^{3-}: x - 6 = -3 \Rightarrow x = +3$



F^- ion is a weak field ligand and does not cause pairing of electrons.

$[\text{CoF}_6]^{3-}:$

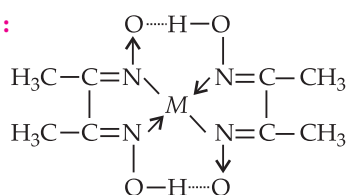


$[\text{CoF}_6]^{3-}$ ion is highly paramagnetic in nature and magnetic moment corresponds to four unpaired electrons.

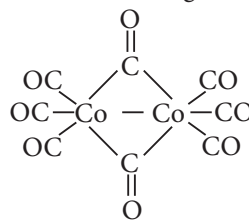
22. (d): The oxidation number of Pt in Zeise's salt is +2. Zeise's salt is ionic complex with the formula, $\text{K}[\text{PtCl}_3(\text{C}_2\text{H}_4)]$.

23. (3): The oxidation state of Fe in the complex is +1. Thus, Fe^+ has configuration $3d^7$. Thus, there are three unpaired electrons.

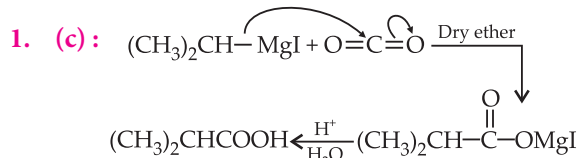
24. (4):



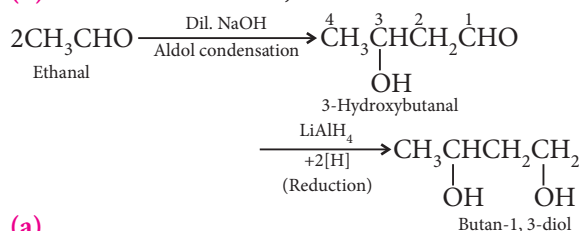
25. (2): There are 2 bridged CO ligands in $[\text{Co}_2(\text{CO})_8]$



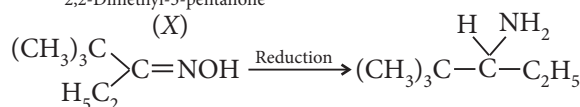
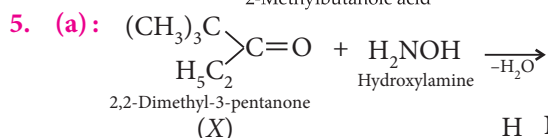
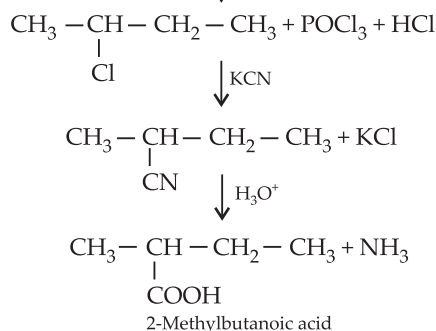
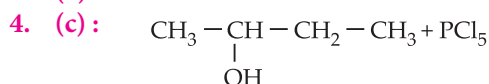
ALDEHYDES, KETONES AND CARBOXYLIC ACIDS



2. (d): Ethanal to butane-1, 3-diol

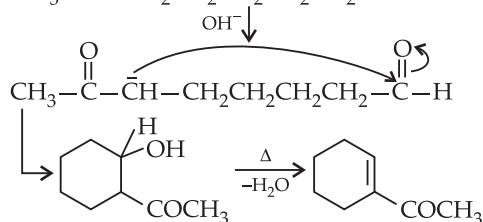


3. (a)



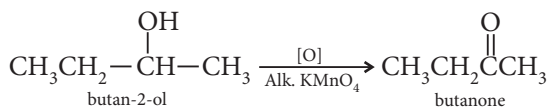
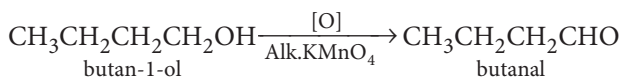
6. (d)

7. (c): Phosphorus converts a little of the acid into acid chloride which is more reactive than the parent carboxylic acid. Thus it is the acid chloride, not the acid itself, that undergoes chlorination on the α -carbon.

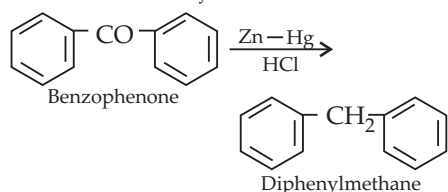
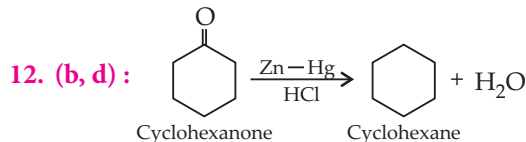


9. (c): Chloroacetic acid is stronger acid than acetic acid due to $-I$ -effect of 'Cl'. Phenoxide ion is stabilised by resonance thus, phenol is more acidic than ethanol as no such stabilisation occurs in ethoxide. Acetic acid is stronger acid than phenol. The correct order of increasing acidic strength is Ethanol < Phenol < Acetic acid < Chloroacetic acid.

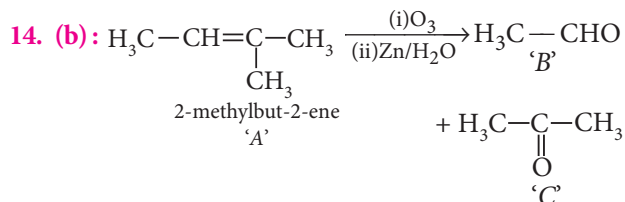
10. (b): Alkaline KMnO_4 is a strong oxidising agent. It oxidises primary alcohols into aldehydes and secondary alcohols into ketones.



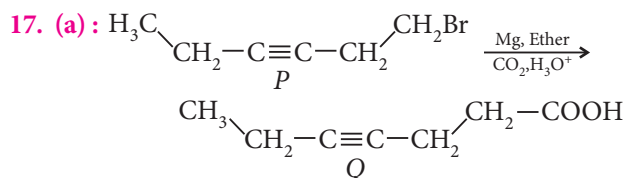
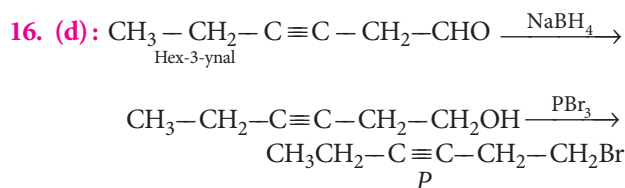
11. (b, c)



13. (a, b, c)



15. (a): 'B' is $\rightarrow \text{CH}_3\text{CHO}$ and 'C' is H_3CCOCH_3 .

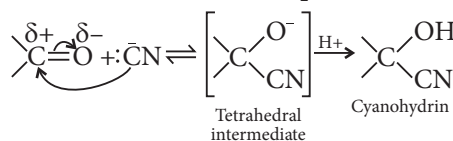
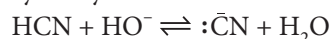


18. (a)

19. (d)

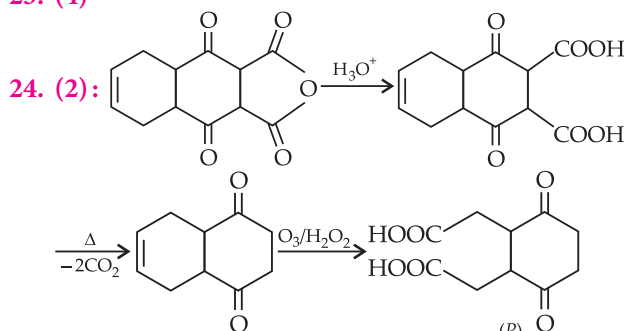
20. (c): The H-atoms of the $-\text{CH}_2-$ group are more acidic than those of $-\text{CH}_3$ group.

21. (c): Aldehydes and ketones react with hydrogen cyanide to yield cyanohydrins. This reaction occurs very slowly with pure HCN. Therefore, it is catalysed by a base and the generated cyanide ion (CN^-) being a stronger nucleophile readily adds to carbonyl compounds to yield corresponding cyanohydrin.



22. (c): Aldehydes have higher molecular weights and polarity as compared to parent alkanes hence, aldehydes show higher boiling points than parent alkanes. On the other hand, aldehydes are not associated like alcohols thus, have boiling points lower than the corresponding alcohols.

23. (4)



No. of $-\text{COOH}$ groups in the product 'P' is 2.

25. (3): NH_2NH_2 , KOH; HI, red P; Zn/Hg, HCl

MPP-5 CLASS XI

ANSWER KEY

| | | | | |
|---------------|------------|------------|---------|------------|
| 1. (d) | 2. (b) | 3. (a) | 4. (b) | 5. (a) |
| 6. (c) | 7. (b) | 8. (b) | 9. (c) | 10. (b) |
| 11. (d) | 12. (b) | 13. (c) | 14. (a) | 15. (b) |
| 16. (c) | 17. (a) | 18. (d) | 19. (d) | 20. (b, d) |
| 21. (a, b, c) | 22. (b, d) | 23. (b, d) | 24. (1) | 25. (2) |
| 26. (3) | 27. (a) | 28. (c) | 29. (b) | 30. (a) |

ACE YOUR WAY CBSE



Aldehydes, Ketones and Carboxylic Acids Amines

Time Allowed : 3 hours
Maximum Marks : 70

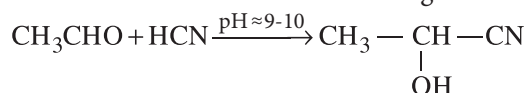
GENERAL INSTRUCTIONS

- All questions are compulsory.
- Q. no. 1 to 5 are very short answer questions and carry 1 mark each.
- Q. no. 6 to 10 are short answer questions and carry 2 marks each.
- Q. no. 11 to 22 are also short answer questions and carry 3 marks each.
- Q. no. 23 is a value based question and carries 4 marks.
- Q. no. 24 to 26 are long answer questions and carry 5 marks each.
- Use log tables if necessary, use of calculators is not allowed.

Previous Years Analysis

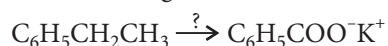
| | 2016 | | 2015 | | 2014 | |
|-------|-------|----|-------|----|-------|----|
| | Delhi | AI | Delhi | AI | Delhi | AI |
| VSA | 1 | — | 1 | — | 2 | 2 |
| SA-I | — | 1 | 1 | 1 | — | — |
| SA-II | 1 | 1 | 1 | 1 | 1 | 1 |
| VBQ | — | — | — | — | — | — |
| LA | 1 | 1 | 1 | 1 | 1 | 1 |

1. Write the mechanism of the following reaction :



2. What is the IUPAC name of $\text{CH}_2=\text{CHCH}_2\text{NHCH}_3$?

3. Name the reagent used in the following reaction :



4. What is the best reagent to convert nitrile to primary amine?

5. Distinguish between the following compounds :
 $\text{C}_6\text{H}_5\text{COCH}_3$ and $\text{C}_6\text{H}_5\text{CHO}$

6. Why aniline does not give Friedel-Crafts reaction?

7. Which acid of each pair given below would you expect to be stronger and why?

- (i) $\text{CH}_3\text{CO}_2\text{H}$ or $\text{CH}_2\text{FCO}_2\text{H}$

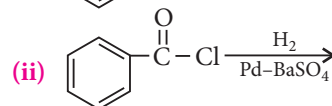
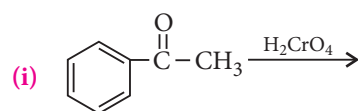
- (ii) $\text{F}_3\text{C}-\text{C}_6\text{H}_4-\text{COOH}$
or $\text{H}_3\text{C}-\text{C}_6\text{H}_4-\text{COOH}$

8. Write the chemical equation to illustrate each of the following name reactions :

- (i) Rosenmund reduction (ii) Cannizzaro reaction

OR

Predict the products of the following reactions :



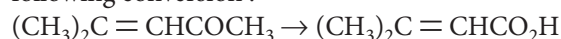
9. Why is methylamine stronger base than ammonia?

10. Give the chemical tests to distinguish between the following pairs of compounds :

- (i) Methylamine and dimethylamine

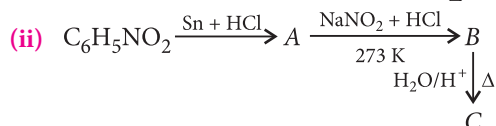
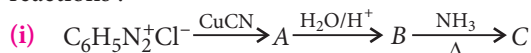
- (ii) Aniline and *N*-methylaniline

11. (i) Suggest a suitable oxidising agent for the following conversion :



(ii) Fluorine is more electronegative than chlorine even then *p*-fluorobenzoic acid is a weaker acid than *p*-chlorobenzoic acid. Explain

12. Give the structures of A, B and C in the following reactions :



13. (i) Out of toluene and benzene which is more easily nitrated ? Explain

(ii) State reasons for the following :

(a) Ethylamine is soluble in water whereas aniline is not soluble in water.

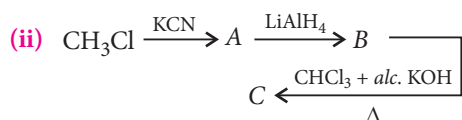
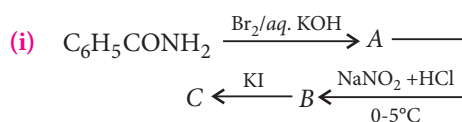
(b) Primary amines have higher boiling points than tertiary amines.

14. How will you convert ethanal into the following compounds?

(i) Butan-1,3-diol (ii) But-2-enal

(iii) But-2-enoic acid

15. Write the structures of A, B and C in the following :



16. How are the following conversions carried out :

(i) Ethyl cyanide to ethanoic acid

(ii) Butan-1-ol to butanoic acid

(iii) Methylbenzene to benzoic acid

17. Amines are more basic than comparable alcohols. Explain giving two reasons.

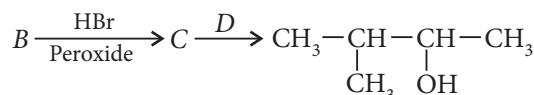
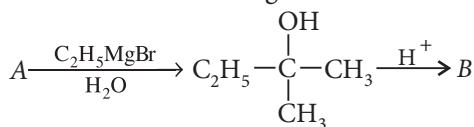
OR

Suggest chemical reactions for the following conversions :

(i) Cyclohexanol \rightarrow Cyclohexylamine

(ii) 1-Hexanenitrile \rightarrow 1-Aminopentane

18. Write the structural formulae of compounds A, B and C and name the reagent D in the following reaction :



19. Write the products formed when ethanal reacts with the following reagents :

(i) $\text{CH}_3\text{MgBr} / \text{H}_3\text{O}^+$ (ii) $\text{Zn-Hg}/\text{conc. HCl}$

(iii) $\text{C}_6\text{H}_5\text{CHO} / \text{dilute NaOH}$

20. Why is carboxyl group in benzoic acid *meta*-directing? Support your answer with two examples.

21. Account for the following observations :

(i) pK_b for aniline is more than that for methylamine.

(ii) Methylamine solution in water reacts with ferric chloride solution to give a precipitate of ferric hydroxide.

(iii) Nitro compounds have higher boiling points than the hydrocarbons having almost the same molecular mass.

22. Write the steps and conditions involved in the following conversions :

(i) Acetophenone to 2-phenylbutan-2-ol

(ii) Propene to acetone

23. Surbhi, a class XII student was discussing about the wide use of colours in fabrics as well as in the food items with her mother. She told her about the harmful effects of azo dyes and colouring components particularly used in food items and stressed on the use of only natural dyes for colouring of food items.

(i) What are azo dyes? Give example.

(ii) Name an azo dye which has been used in food items and considered to be a cancer suspect.

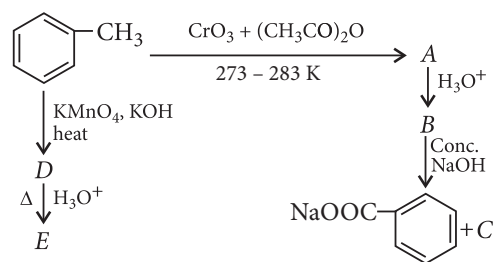
(iii) Name two natural food dyes.

(iv) What are the values expressed by surbhi?

24. A ketone A ($\text{C}_4\text{H}_8\text{O}$), which undergoes haloform reaction gives compound B on reduction. B on heating with sulphuric acid gives a compound C which forms monozonide D. D on hydrolysis in presence of zinc dust gives E. Identify A, B, C, D and E. Write the reactions involved.

OR

Identify A to E in the following series of reactions :



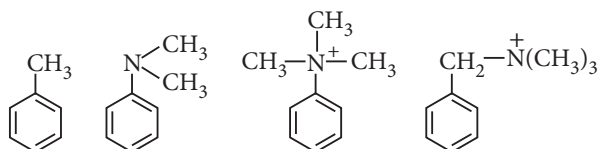
25. (i) How will you convert acetic acid to
 (a) malonic acid
 (b) *tert*-butyl alcohol
 (ii) Give chemical tests to distinguish between the following pairs of compounds :
 (a) Methyl acetate and ethyl acetate.
 (b) Benzaldehyde and benzoic acid.
 (c) Phenol and benzoic acid.

OR

- (i) State reasons for the following :
 (a) Monochloroethanoic acid has a higher pK_a value than dichloroethanoic acid.
 (b) Ethanoic acid is a weaker acid than benzoic acid.
 (ii) How will you convert acetic acid to
 (a) glycine (b) acetylene
 (c) ethylamine?

26. (i) Rearrange the following in an increasing order of their basic strengths :
 $C_6H_5NH_2$, $C_6H_5N(CH_3)_2$, $(C_6H_5)_2NH$ and CH_3NH_2

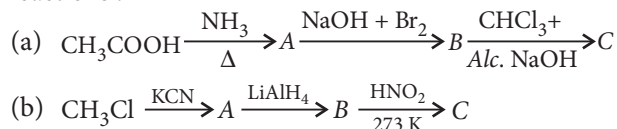
- (ii) Give increasing order towards electrophilic substitution of the following compounds :



OR

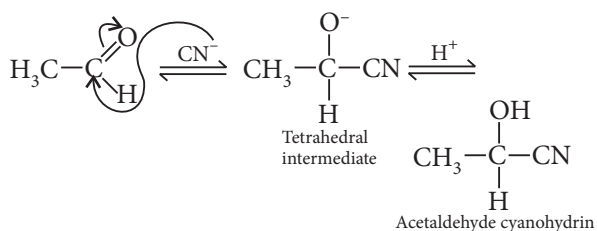
- (i) Write the structures of main products when benzenediazonium chloride ($C_6H_5N_2^+Cl^-$) reacts with the following reagents :
 (a) BF_3/Δ (b) Cu/HBr

- (ii) Write the structures of A, B and C in the following reactions :



SOLUTIONS

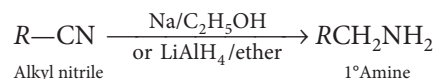
1. $HCN + OH^- \rightleftharpoons CN^- + H_2O$



2. $CH_2 = CHCH_2NHCH_3$
N-Methylprop-2-en-1-amine

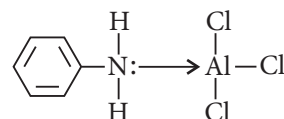
3. Alkaline potassium permanganate ($KMnO_4$, KOH)

4. Reduction of nitriles with Na/C_2H_5OH or $LiAlH_4$ gives primary amines.



5. Benzaldehyde and acetophenone can be distinguished by Tollens' test. Benzaldehyde reduces Tollens' reagent whereas acetophenone does not.

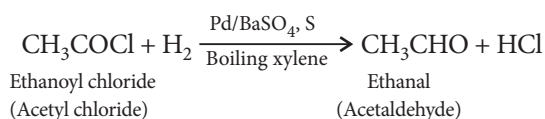
6. Lone pair of electrons on nitrogen atom of $-NH_2$ group in aniline conjugates with $AlCl_3$ catalyst to form a salt, which acts as a strong electron withdrawing group. As a result, it reduces the electron density in the benzene ring. Hence, aniline does not undergo Friedel-Crafts reaction.



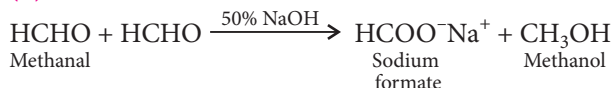
7. (i) H_2FCOOH is a stronger acid. Fluorine is an electronegative atom. Electron withdrawing group or atom stabilises the carboxylate ion and increases the acidity due to dispersal of negative charge.

- (ii) $F_3C-C_6H_4-COOH$ is a stronger acid. $-CF_3$ is an electron withdrawing group thus, increases the acid strength.

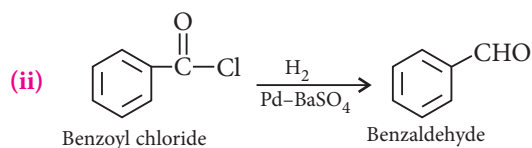
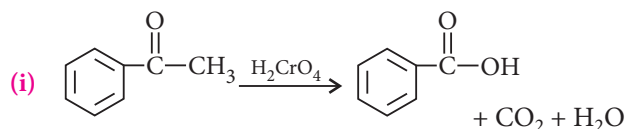
8. (i) Rosenmund reduction :



- (ii) Cannizzaro reaction :



OR



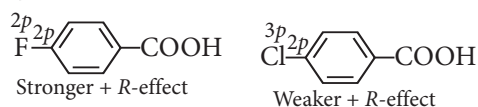
9. Both ammonia and methylamine have a lone pair of electrons and therefore, behave as Lewis bases. The alkyl group in CH_3NH_2 is electron releasing in nature thus, exhibit +I inductive effect. As a result, its electron releasing tendency becomes more. Thus, methylamine is more basic than ammonia.

10. (i) Methylamine (1° amine) gives carbylamine test, i.e., on treatment with alc. KOH and chloroform, followed by heating it gives offensive odour of methyl isocyanide. Dimethylamine (2° amine) does not give this test.

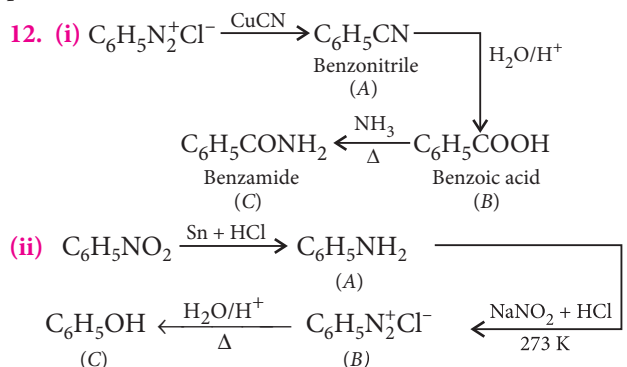
(ii) Aniline gives carbylamine test, i.e., on treatment with alc. KOH and chloroform followed by heating it gives offensive odour of phenyl isocyanide but *N*-methylaniline being secondary amine, does not show this test.

11. (i) The most suitable reagent for this oxidation is NaOI (I_2/NaOH) since methyl ketones on treatment with NaOI undergo iodoform reaction to give iodoform along with the sodium salt of a carboxylic acid having one carbon atom less than the starting methyl ketone.

(ii) Since halogens are more electronegative than carbon and also possess lone pairs of electrons, therefore, they exert both $-I$ and $+R$ -effects. Now in F, the lone pairs of electrons are present in $2p$ -orbitals but in Cl, they are present in $3p$ -orbitals. Since $2p$ -orbitals of F and C atoms are of almost equal size, therefore, the $+R$ -effect is more pronounced in *p*-fluorobenzoic acid than in *p*-chlorobenzoic acid.



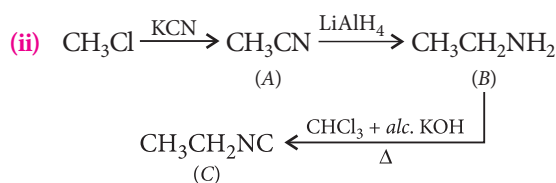
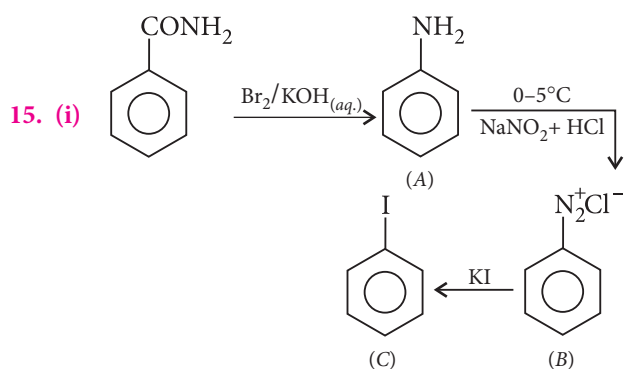
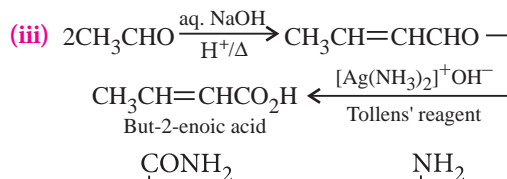
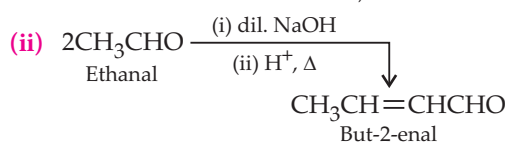
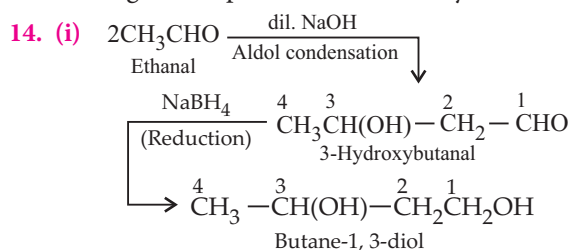
Thus, in *p*-fluorobenzoic acid, $+R$ -effect outweighs the $-I$ -effect but in *p*-chlorobenzoic acid, it is the $-I$ -effect which outweighs the $+R$ -effect. Consequently, *p*-fluorobenzoic acid is a weaker acid than *p*-chlorobenzoic acid.

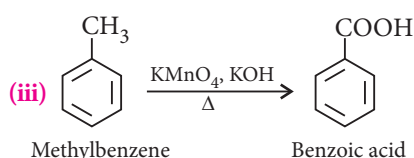
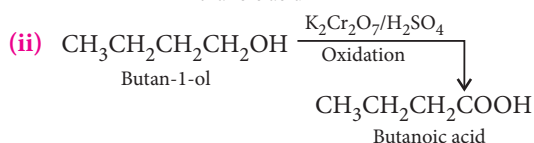
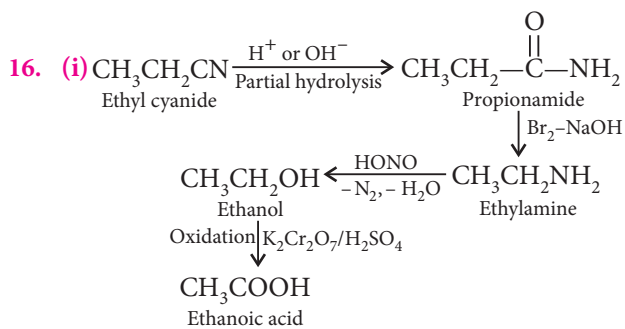


13. (i) Nitration is an electrophilic substitution reaction and thus, occurs more readily at a site where the electron-density is more. In toluene, there is electron-donating $-\text{CH}_3$ group. In other words, the electron density in the toluene ring is much more than in the benzene ring. As a result, toluene is nitrated more easily than benzene.

(ii) (a) Ethylamine is soluble in water due to formation of intermolecular hydrogen bonds with water molecules. However, in aniline due to large hydrophobic aryl group the extent of hydrogen bonding decreases considerably and hence, aniline is insoluble in water.

(b) Primary amines ($R-\text{NH}_2$) have two hydrogen atoms on nitrogen which can undergo intermolecular hydrogen bonding whereas no such hydrogen bonding is present in tertiary amines ($R_3\text{N}$). So, primary amines boil at a higher temperature than tertiary amines.

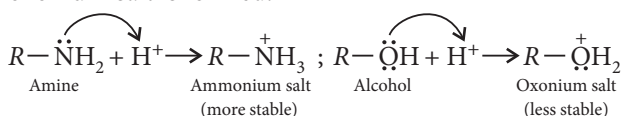




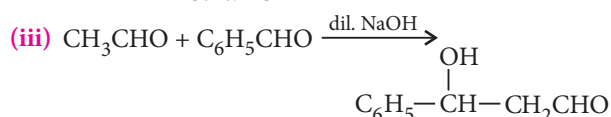
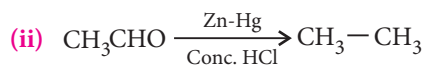
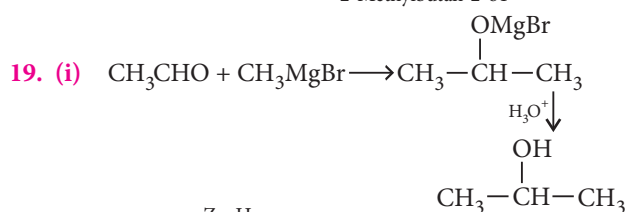
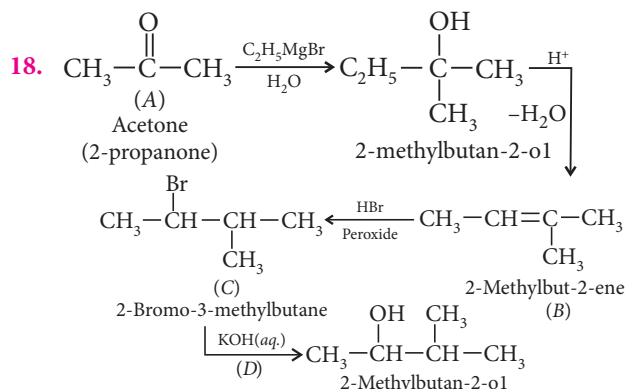
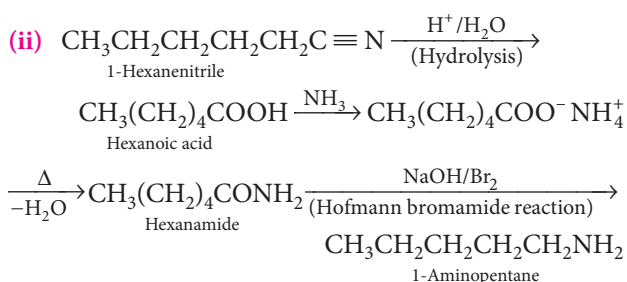
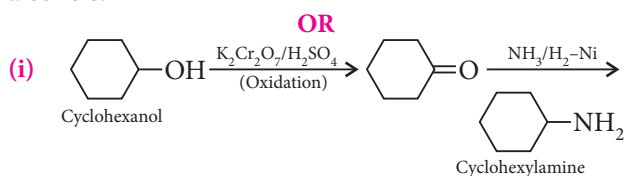
17. Amines are more basic than comparable alcohols because of the following two reasons :

(i) N being less electronegative is more willing to donate its lone pair of electrons to a proton than the more electronegative O atom. Therefore, amines are more basic than alcohols.

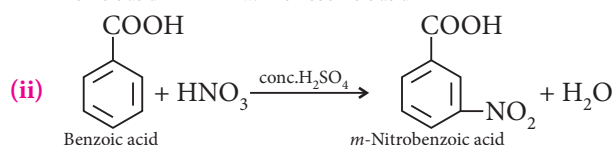
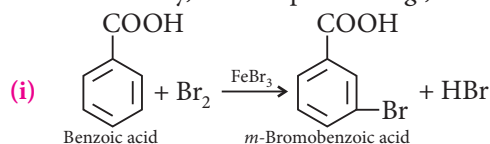
(ii) When an amine accepts a proton, ammonium salt is formed and when an alcohol accepts a proton oxonium salt is formed.



Since N being less electronegative can accommodate the positive charge better than the more electronegative O atom, therefore, ammonium salt is more stable than oxonium salt. As a result, amines are more basic than alcohols.



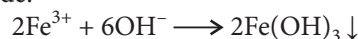
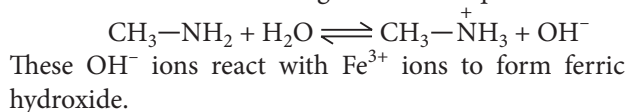
20. In benzoic acid, carboxyl group is *meta*-directing because it is electron withdrawing, therefore, there is +ve charge on *o*- and *p*-positions, therefore, electrophilic substitution takes place at *m*-position due to greater electron density, at *meta*-position e.g.,



21. (i) In aniline, the lone pair of electrons on N-atom are delocalised over the benzene ring. As a result, electron density on the nitrogen decreases. In contrast, in CH_3NH_2 , +I-effect of $-\text{CH}_3$ group increases the electron density on N-atom.

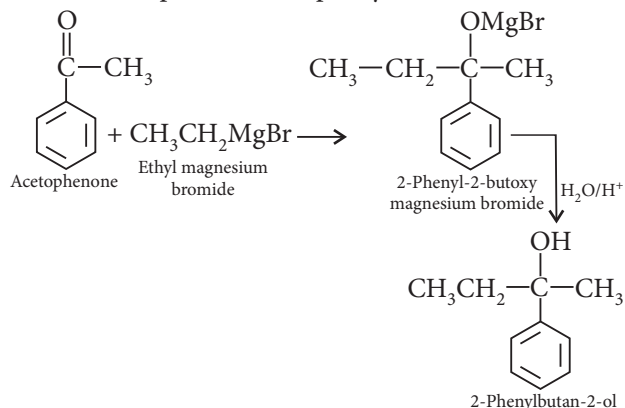
Therefore, aniline is a weaker base than methylamine and hence, its pK_b value is higher than that of methylamine.

(ii) Methylamine forms hydroxide ions when dissolved in water due to the following acid - base equilibrium.

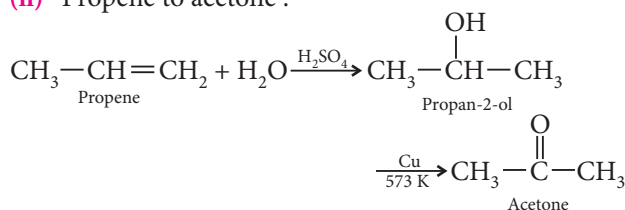


(iii) Nitro compounds are highly polar molecules. Due to this polarity they have strong intermolecular dipole-dipole interactions so, nitro compounds have higher boiling points in comparison to the hydrocarbons having almost same molecular mass.

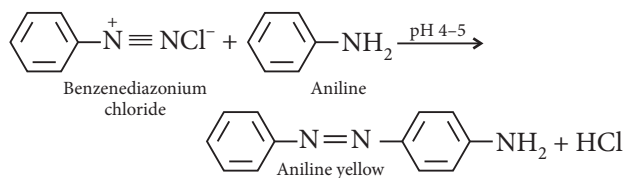
22. (i) Acetophenone to 2-phenylbutan-2-ol :



(ii) Propene to acetone :



23. (i) Dyes containing -N=N- as functional group are called azo dyes. For example, the simplest azo dye is aniline yellow obtained by coupling benzenediazonium chloride with aniline.

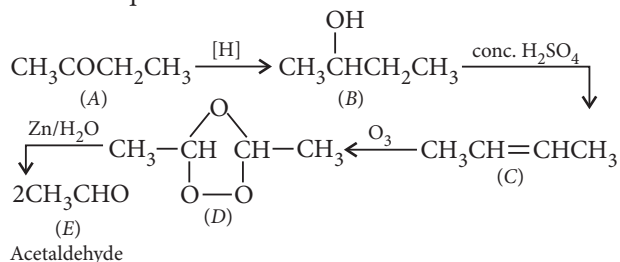


(ii) Tartrazine is a synthetic azo dye which has been used in food items but considered to be a cancer suspect.

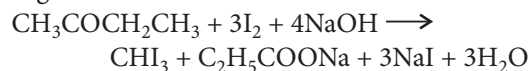
(iii) Natural food dyes are saffron and turmeric.

(iv) Surbhi has shown her concern about healthcare and applied her knowledge on the use of only natural dyes for colouring of food items.

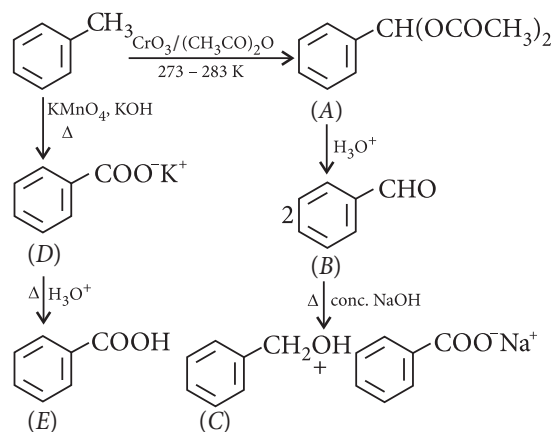
24. The equations involved are :



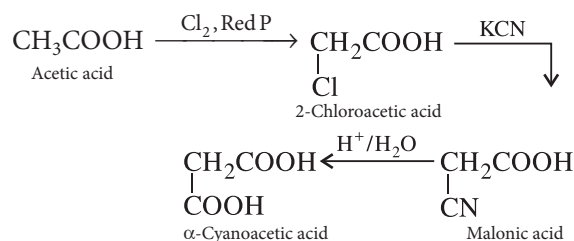
A gives haloform reaction as :



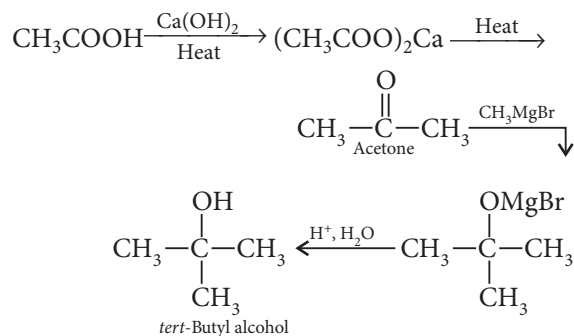
OR



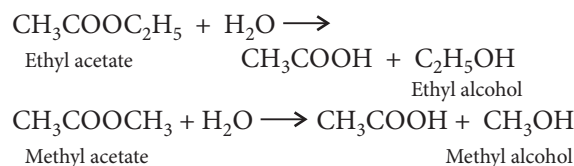
25. (i) (a) Acetic acid to malonic acid :



(b) Acetic acid to *tert*-butyl alcohol :



(ii) (a) Ethyl acetate is hydrolysed slowly by water to form ethyl alcohol while methyl acetate gives methyl alcohol.



The hydrolysis product of ethyl acetate *i.e.*, ethanol undergoes iodoform test with iodine and alkali.

$$\text{C}_6\text{H}_5\text{CHO} + 2[\text{Ag}(\text{NH}_3)_2]^+\text{OH}^- \longrightarrow \text{C}_6\text{H}_5\text{COO}^- + 2\text{Ag} + 4\text{NH}_3 + 2\text{H}_2\text{O}$$

Silver mirror

$$\text{C}_6\text{H}_5\text{COOH} \xrightarrow{\text{NaHCO}_3} \text{C}_6\text{H}_5\text{COONa} + \text{CO}_2 + \text{H}_2\text{O}$$

Benzoic acid

OR

(b) —COOH group in benzoic acid is attached to sp^2 -carbon of the phenyl ring and is more acidic than acetic acid in which —COOH group is attached to sp^3 -carbon atom of —CH₃ group.

$$\text{CH}_3\text{COOH} \xrightarrow{\text{Cl}_2, \text{P}} \underset{\text{Cl}}{\text{CH}_2}\text{COOH} \xrightarrow{\text{NH}_3} \underset{\text{NH}_2}{\text{CH}_2}\text{COOH}$$

(1) Acetic acid Chloroacetic acid Glycine

$$\begin{array}{c} \text{CH}_3\text{COOH} \xrightarrow{\text{LiAlH}_4} \text{CH}_3\text{CH}_2\text{OH} \xrightarrow{\text{H}^+, 443\text{K}} \text{CH}_2=\text{CH}_2 \\ \text{HC} \equiv \text{CH} \xleftarrow{\text{alc. KOH}} \underset{\text{Br}}{\underset{|}{\text{CH}_2}} - \underset{\text{Br}}{\underset{|}{\text{CH}_2}} \xleftarrow{\text{Br}_2} \end{array}$$

Acetylene


$$\begin{array}{c} \text{CH}_3\text{COOH} \xrightarrow{\text{LiAlH}_4} \text{CH}_3\text{CH}_2\text{OH} \\ \xrightarrow{\text{PCl}_5} \underset{\text{Ethyl chloride}}{\text{CH}_3\text{CH}_2\text{Cl}} \xrightarrow{\text{NH}_3} \underset{\text{Ethylamine}}{\text{CH}_3\text{CH}_2\text{NH}_2} \end{array}$$

(b) Presence of electron donating groups (*i.e.*, CH₃) on the N-atom increases the basicity of substituted aniline w.r.t. C₆H₅NH₂.

$$\text{Ph-N}^+(\text{CH}_3)_3 < \text{Ph-CH}_2\text{-N}^+(\text{CH}_3)_3 < \text{Ph-CH(CH}_3\text{)-N(CH}_3)_2 < \text{Ph-N(CH}_3)_2$$

OR

(b)



Benzenediazonium chloride

Bromobenzene

$$\begin{array}{ccccc} \text{CH}_3\text{COOH} & \xrightarrow[\Delta]{\text{NH}_3} & \text{CH}_3\text{CONH}_2 & \xrightarrow{\text{Br}_2 + \text{NaOH}} & \text{CH}_3\text{NH}_2 \\ & & (A) & & (B) \\ & & & & \downarrow \text{NaOH}_{(alc.)} \quad \text{CHCl}_3 \\ & & & & \text{CH}_3\text{NC} \\ & & & & (C) \end{array}$$

(b) $\text{CH}_3\text{Cl} \xrightarrow{\text{KCN}} \text{CH}_3\text{CN} \xrightarrow{\text{LiAlH}_4} \text{CH}_3\text{CH}_2\text{NH}_2 \xrightarrow[\text{273 K}]{\text{HNO}_2} \text{CH}_3\text{CH}_2\text{OH}$

MPP-5 MONTHLY Practice Problems

Class XII

This specially designed column enables students to self analyse their extent of understanding of specified chapters. Give yourself four marks for correct answer and deduct one mark for wrong answer. Self check table given at the end will help you to check your readiness.

The *d* - and *f*-Block Elements Coordination Compounds

Total Marks : 120

Time Taken : 60 Min.

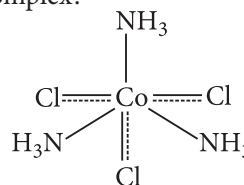
NEET / AIIMS

Only One Option Correct Type

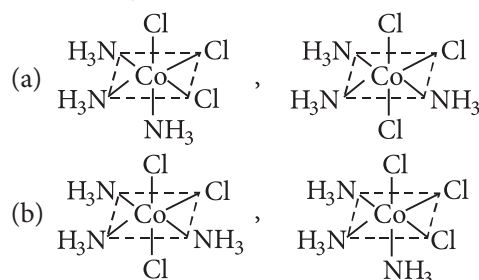
- What would happen when a solution of potassium chromate is treated with an excess of dilute nitric acid?
 - $\text{Cr}_2\text{O}_7^{2-}$ and H_2O are formed.
 - CrO_4^{2-} is reduced to +3 state of Cr.
 - CrO_4^{2-} is oxidised to +7 state of Cr.
 - Cr^{3+} and $\text{Cr}_2\text{O}_7^{2-}$ are formed.
- The complex which involves outer orbital hybridisation of central metal ion is
 - $[\text{Zn}(\text{NH}_3)_6]^{2+}$
 - $[\text{Cr}(\text{NH}_3)_6]^{3+}$
 - $[\text{V}(\text{NH}_3)_6]^{3+}$
 - $[\text{Co}(\text{NH}_3)_6]^{3+}$
- Effective atomic number (EAN) of Fe in brown ring complex $[\text{Fe}(\text{H}_2\text{O})_5\text{NO}]^{2+}$ is
 - 36
 - 37
 - 38
 - 39
- A solution containing 2.675 g of $\text{CoCl}_3 \cdot 6\text{NH}_3$ (molar mass = 267.5 g mol^{-1}) is passed through a cation exchanger. The chloride ions obtained in solution were treated with excess of AgNO_3 to give 4.78 g of AgCl (molar mass = 143.5 g mol^{-1}). The formula of the complex is (At. mass of Ag = 108 u)
 - $[\text{CoCl}(\text{NH}_3)_5]\text{Cl}_2$
 - $[\text{Co}(\text{NH}_3)_6]\text{Cl}_3$
 - $[\text{CoCl}_2(\text{NH}_3)_4]\text{Cl}$
 - $[\text{CoCl}_3(\text{NH}_3)_3]$
- Zn gives H_2 gas with H_2SO_4 and HCl but not with HNO_3 because
 - Zn acts as an oxidising agent when reacts with HNO_3

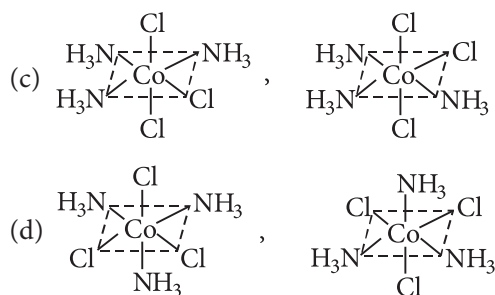
- HNO_3 is weaker acid than H_2SO_4 and HCl
- In electrochemical series Zn is above hydrogen
- NO_3^- ion is reduced in preference to hydronium ion.

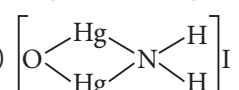
- Which of the following statements is correct about the given complex?



- It is a molecular complex.
 - It gives four ions in the aqueous solution.
 - Primary valency of cobalt is six.
 - All are correct.
- Of the following outer electronic configurations of the atoms, the highest oxidation state is exhibited by which one of them?
 - $(n-1)d^8 ns^2$
 - $(n-1)d^5 ns^1$
 - $(n-1)d^3 ns^2$
 - $(n-1)d^5 ns^2$
 - Which of the following pairs of structures represents facial and meridional isomers (geometrical isomers) respectively?





9. Alkaline NH_4Cl solution reacts with K_2HgI_4 (Nessler's reagent) forming
- (a) $(\text{HgNH}_2\text{Cl} + \text{Hg})$ - Black residue
- (b)  - Brown iodide of Millon's base
- (c) $\text{K}_2[\text{O}-\text{Hg}-\text{NH}_2\text{Cl}]\text{I}$ - Brown iodide of Millon's base
- (d) none of the above.
10. If in the complex $[\text{ML}_6]^{3+}$, the metal has oxidation number +3 with $(n-1)d^6$ configuration and L is strong ligand, the complex is likely to be
- (a) paramagnetic due to 1 unpaired electron
- (b) paramagnetic due to 4 unpaired electrons
- (c) paramagnetic due to 6 unpaired electrons
- (d) diamagnetic because of no unpaired electron.
11. Basic character of the transition metal monoxides follows the order
- (a) $\text{VO} > \text{CrO} > \text{TiO} > \text{FeO}$
- (b) $\text{CrO} > \text{VO} > \text{FeO} > \text{TiO}$
- (c) $\text{TiO} > \text{FeO} > \text{VO} > \text{CrO}$
- (d) $\text{TiO} > \text{VO} > \text{CrO} > \text{FeO}$
12. The IUPAC name for $\text{K}[\text{SbCl}_5\text{C}_6\text{H}_5]$ is
- (a) Potassium pentachloroantimony(III)phenyl
- (b) Potassium pentachloro(phenyl)antimonate(V)
- (c) Potassium phenylchloroantimonate(V)
- (d) Potassium benzoantimony(III)chloride.

Assertion & Reason Type

Directions : In the following questions, a statement of assertion is followed by a statement of reason. Mark the correct choice as :

- (a) If both assertion and reason are true and reason is the correct explanation of assertion.
- (b) If both assertion and reason are true but reason is not the correct explanation of assertion.
- (c) If assertion is true but reason is false.
- (d) If both assertion and reason are false.
13. **Assertion :** Glycinate ion is an example of monodentate ligand.
- Reason :** Glycinate contains N as the donor atom.

14. **Assertion :** Cuprous salts are colourless.

Reason : $\text{Cu}^+(3d^{10})$ has no unpaired electron.

15. **Assertion :** Spot of iron-rusting can be removed by addition of oxalic acid.

Reason : Water soluble complex is formed with oxalic acid.

JEE MAIN / JEE ADVANCED / PETs

Only One Option Correct Type

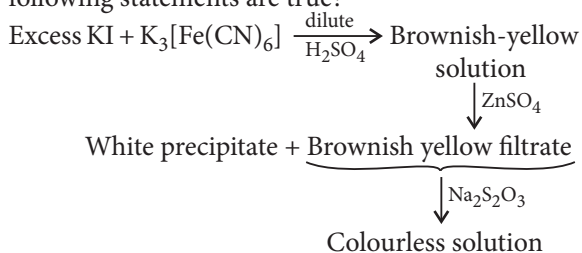
16. Which of the following complexes is used as an anti-cancer agent?
- (a) *mer*- $[\text{Co}(\text{NH}_3)_3\text{Cl}_3]$ (b) *cis*- $[\text{PtCl}_2(\text{NH}_3)_2]$
- (c) *cis*- $\text{K}_2[\text{PtCl}_2\text{Br}_2]$ (d) $\text{Na}_2[\text{CoCl}_4]$
17. In the reaction $\text{Ag}_2\text{S} + \text{Na}_2\text{CO}_3 \xrightarrow{\Delta}$, one of the product is
- (a) Ag_2CO_3 (b) Ag_2O
- (c) Ag (d) CO_2
18. In the reaction $[\text{Ni}(\text{NH}_3)_2]^{2+} \xrightarrow{\text{conc. HCl}}$ 'A' + 'B', the molecular formula of both 'A' and 'B' is same. 'A' can be converted to B by boiling in dil. HCl. 'A' on reaction with oxalic acid yields a complex having the formula $[\text{Ni}(\text{NH}_3)_2(\text{C}_2\text{O}_4)]$ but 'B' does not. Which of the following is correct for complexes 'A' and 'B'?
- (a) 'A' is square planar but 'B' is tetrahedral.
- (b) 'A' and 'B' both are tetrahedral but 'A' is optically active compound whereas 'B' is optically inactive.
- (c) Both 'A' and 'B' are square planar. 'A' is *trans*-isomer and 'B' is *cis*-isomer.
- (d) Both 'A' and 'B' are square planar, 'A' is *cis*-isomer and 'B' is *trans*-isomer.
19. Identify the correct statement.
- (a) FeI_3 is stable in aqueous solution.
- (b) An acidified solution of K_2CrO_4 gives yellow precipitate on mixing with lead acetate.
- (c) The species $[\text{CuCl}_4]^{2-}$ exists but $[\text{CuI}_4]^{2-}$ does not.
- (d) Both copper (I) and copper (II) salts are known in aqueous solution.

More than One Options Correct Type

20. Which of the following ions show higher spin only magnetic moment values?
- (a) Ti^{3+} (b) Mn^{2+} (c) Fe^{2+} (d) Co^{2+}
21. Metal M forms a coloured complex with ligand A and colourless complex with ligand B, which has a larger formation constant than that of M with A. Concentration of M ion can be estimated by
- (a) using A as titrant and B as the indicator
- (b) the end point which corresponds to just appearance of colour

- (c) using *B* as titrant and *A* as the indicator
 (d) the end point which corresponds to just disappearance of colour.

22. For the given aqueous reactions, which of the following statements are true?



- (a) The first reaction is a redox reaction.
 (b) White precipitate is $\text{Zn}_3[\text{Fe}(\text{CN})_6]_2$.
 (c) Addition of filtrate to starch solution gives blue colour.
 (d) White precipitate is soluble in NaOH solution.
23. Which of the following statements are correct about Wilkinson's catalyst?
- (a) It is used as a homogeneous catalyst for selective hydrogenation of organic molecules at room temperature and pressure.
 (b) It is a tetrahedral complex.
 (c) It does not have unpaired electrons.
 (d) Its formula is $\text{TiCl}_4 + \text{Al}(\text{C}_2\text{H}_5)_3$.

Integer Answer Type

24. The number of chelate rings present in the complex $\text{K}_2[\text{Ni}(\text{EDTA})]$ is
25. The oxidation number of Mn in the product of alkaline oxidative fusion of MnO_2 is
26. The number of unpaired electrons in square planar complex of Co^{2+} is

Comprehension Type

When we pass carbon dioxide gas through a green coloured solution of potassium manganate, the colour of solution changes to purple and a brown coloured solid gets precipitated.

The green colour of potassium manganate solution also becomes purple when it is subjected to electrolysis using iron rods as cathode as well as anode.

27. The change of colour from green to purple is due to
 (a) conversion of Mn^{6+} to Mn^{7+}
 (b) conversion of Mn^{6+} to Mn^{4+}
 (c) conversion of Mn^{4+} to Mn^{7+}
 (d) conversion of Mn^{4+} to Mn^{6+}

28. In the brown solid precipitated out, the oxidation state of Mn is

- (a) +2 (b) +4 (c) +6 (d) +7

Matrix Match Type

29. Match the entries listed in Column I with appropriate entries listed in Column II.

| Column I | Column II |
|---------------------------------------|--------------------------------------|
| (A) K_2MnO_4 | (P) Transition element in +6 state |
| (B) KMnO_4 | (Q) Oxidising agent in acidic medium |
| (C) $\text{K}_2\text{Cr}_2\text{O}_7$ | (R) Manufactured from pyrolusite ore |
| (D) K_2CrO_4 | (S) Manufactured from chromite ore |

| A | B | C | D |
|-----------|-----|-----|-----|
| (a) P,Q | P,S | Q,R | P,R |
| (b) P,R | Q,R | P,Q | P,S |
| (c) P,R,Q | Q | S,R | R |
| (d) Q,R,S | R,S | P,Q | Q,R |

30. Match the complexes in Column I with their properties listed in Column II.

| Column I | Column II |
|---|---------------------------------------|
| (A) $[\text{Co}(\text{NH}_3)_4(\text{H}_2\text{O})_2]\text{Cl}_2$ | (P) Geometrical isomers |
| (B) $[\text{Pt}(\text{NH}_3)_2\text{Cl}_2]$ | (Q) Paramagnetic |
| (C) $[\text{Co}(\text{H}_2\text{O})_5\text{Cl}]\text{Cl}$ | (R) Diamagnetic |
| (D) $[\text{Ni}(\text{H}_2\text{O})_6]\text{Cl}_2$ | (S) Metal ion with +2 oxidation state |

| A | B | C | D |
|-----------|-------|-------|-----|
| (a) Q,S | R,P | R,S | P,S |
| (b) P,Q,S | Q,S | P,R,S | Q,S |
| (c) P,R,S | S,R | P,S | P,Q |
| (d) P,Q,S | P,R,S | Q,S | Q,S |



Keys are published in this issue. Search now! ☺

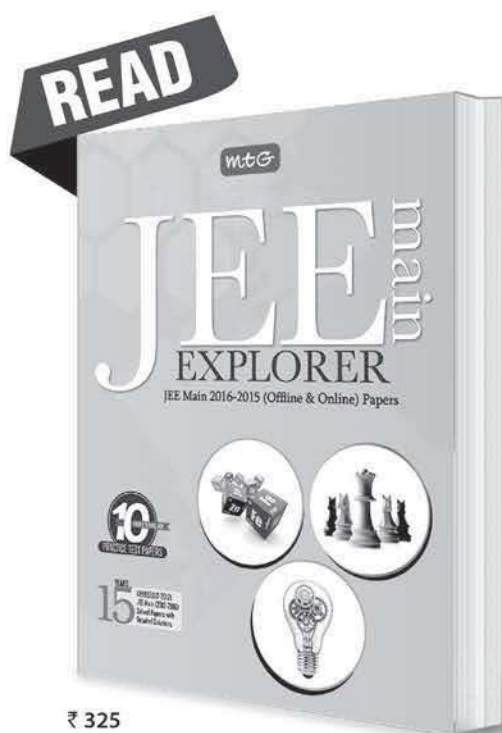
SELF CHECK

No. of questions attempted
 No. of questions correct
 Marks scored in percentage

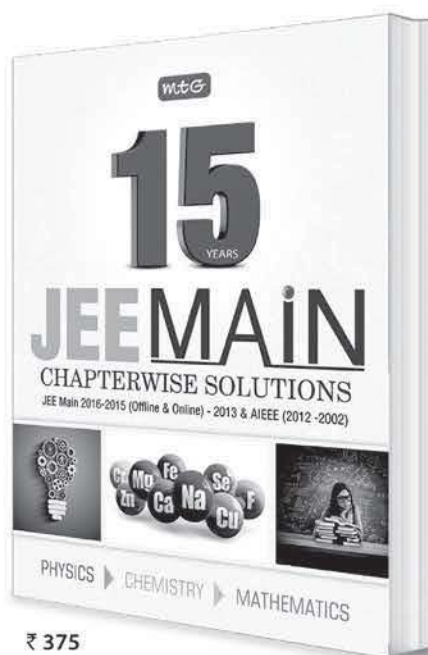
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| | | |
|--------|-------------------|--|
| > 90% | EXCELLENT WORK ! | You are well prepared to take the challenge of final exam. |
| 90-75% | GOOD WORK ! | You can score good in the final exam. |
| 74-60% | SATISFACTORY ! | You need to score more next time. |
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CHEMISTRY MUSING

Chemistry Musing was started from August '13 issue of Chemistry Today with the suggestion of Shri Mahabir Singh. The aim of Chemistry Musing is to augment the chances of bright students preparing for JEE (Main and Advanced) / NEET / AIIMS / PMTs with additional study material.

In every issue of Chemistry Today, 10 challenging problems are proposed in various topics of JEE (Main and Advanced) / NEET. The detailed solutions of these problems will be published in next issue of Chemistry Today.

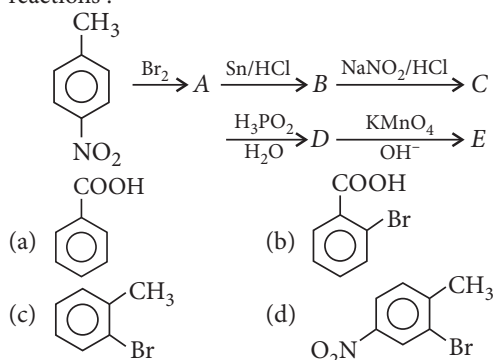
The readers who have solved five or more problems may send their solutions. The names of those who send atleast five correct solutions will be published in the next issue.

We hope that our readers will enrich their problem solving skills through "Chemistry Musing" and stand in better stead while facing the competitive exams.

PROBLEM Set 40

JEE MAIN/NEET

1. A metal weighing 0.43 g was dissolved in 50 mL of 1N H_2SO_4 . The unreacted H_2SO_4 required 14.2 mL of 1N NaOH for neutralisation. The equivalent weight of the metal is
(a) 12.01 (b) 1.20 (c) 120 (d) 0.12
2. According to Ellingham diagram, the oxidation reaction of carbon to carbon monoxide may be used to reduce which one of the following oxides at the lowest temperature?
(a) Al_2O_3 (b) Cu_2O (c) MgO (d) ZnO
3. The equivalent conductance at infinite dilution of the salt MX is $160.84 \text{ ohm}^{-1} \text{ cm}^2 \text{ eq}^{-1}$. If the transport number of M^+ is 0.40, the ionic mobility of X^- in $\text{cm}^2 \text{ V}^{-1} \text{ s}^{-1}$ is
(a) 3.9×10^{-5} (b) 6.7×10^{-4}
(c) 2.5×10^{-3} (d) 1.0×10^{-3}
4. Identify the product (E) in the following sequence of reactions :



5. In the mineral spinel (MgAl_2O_4) which of the following statements is correct?
(a) $\frac{1}{8}$ th of the tetrahedral voids and $\frac{1}{2}$ th of the octahedral voids are occupied.
(b) All the octahedral voids are occupied while $\frac{1}{4}$ th of the tetrahedral voids are occupied.
(c) $\frac{1}{2}$ th of the tetrahedral voids are occupied and $\frac{1}{8}$ th of the octahedral voids are occupied.

- (d) $\frac{1}{4}$ th of the octahedral voids are occupied and $\frac{1}{4}$ th of the tetrahedral voids are occupied.

JEE ADVANCED

6. 1 g of Ra^{226} is placed in an evacuated tube whose volume is 5 cc and then sealed. Assuming that each Ra nucleus emits four α -particles and all the particles are retained in the tube, pressure developed inside the tube at 27°C after 1590 years will be ($t_{1/2}$ for Ra is 1590 years)
(a) 0.435 atm (b) 4.35 atm
(c) 43.5 atm (d) 435 atm

COMPREHENSION

In a fuel cell (device used for producing electricity directly from a chemical reaction), methanol is used as a fuel and oxygen gas is used as an oxidiser. The standard enthalpy of combustion of methanol is -726 kJ mol^{-1} . The standard free energies of formation of $\text{CH}_3\text{OH}_{(l)}$, $\text{CO}_{2(g)}$ and $\text{H}_2\text{O}_{(l)}$ are -166.3 , -394.4 and $-237.1 \text{ kJ mol}^{-1}$ respectively.

7. The standard free energy change of the reaction will be
(a) $-597.8 \text{ kJ mol}^{-1}$ (b) $-298.9 \text{ kJ mol}^{-1}$
(c) $-465.2 \text{ kJ mol}^{-1}$ (d) $-702.3 \text{ kJ mol}^{-1}$
8. The standard internal energy change of the cell reaction will be
(a) $-727.24 \text{ kJ mol}^{-1}$ (b) $-724.76 \text{ kJ mol}^{-1}$
(c) $-728.48 \text{ kJ mol}^{-1}$ (d) $-723.42 \text{ kJ mol}^{-1}$

INTEGER VALUE

9. For the decomposition of N_2O_5 at 127°C , i.e.,

$$\text{N}_2\text{O}_{5(g)} \rightarrow \text{N}_2\text{O}_{4(g)} + \frac{1}{2} \text{O}_{2(g)}$$
 if the initial pressure is 114 mm and after 25 minutes of the reaction, total pressure of the gaseous mixture is 133 mm, the average rate of reaction is $10^{-x} \text{ mol L}^{-1} \text{ s}^{-1}$. The value of x is
10. In an adsorption experiment, a graph between $\log (x/m)$ versus $\log P$ is found to be linear with a slope of 45° . The intercept on the $\log (x/m)$ axis is found to be 0.3010. The amount of the gas in grams adsorbed per gram of the adsorbent under a pressure of 2 atm will be $\diamond\diamond$



CONCEPT BOOSTER

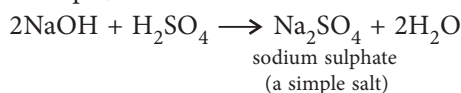
Dear students, hope it was a great festive season for all of you. Now let's get back to the work. This month my article is on Coordination Chemistry and it will be continued ... my focus is to discuss the toughest parts of the chapter in a lucid manner. Stereochemistry of coordination complex is my first priority. Hop you will like it. Please do take care and keep practicing.

*Arunava Sarkar

Transition metals are the important part along with the ligands in a coordination compound or more precisely complex salt. Discussion about complex salt is always done along with the discussion of simple and double salts.

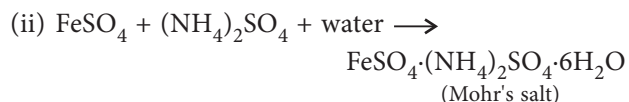
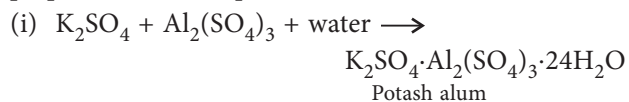
We all know that simple salts are formed due to the simple interaction in between an acid and a base.

For example,



Now, I must tell you that this is the simple salt only which makes the basis of double and complex salts. Don't believe this?? Ok! Let me show you. ☺

Remember that when two or more simple salts are mixed in correct or requisite proportion and they are allowed to crystallise together then double salts are prepared. For example,



Point to remember is that double salts exist in the crystalline form only because, in the aqueous solution, these salts exist in their ionic form. For example in aqueous solution, Mohr's salt gives Fe^{2+} , NH_4^+ and SO_4^{2-} ions.

Now, it is the turn of complex salt. $\text{K}_4[\text{Fe}(\text{CN})_6]$ is known as potassium ferrocyanide and it is well-known complex salt.

When two simple salts are separately dissolved in water and then mixed and the mixed solution is concentrated and allowed to crystallise then, complex salt is obtained. Like for preparing $\text{K}_4[\text{Fe}(\text{CN})_6]$ we need FeSO_4 (ferrous salt) and KCN (potassium cyanide) solutions.

Now, the basic difference between double salt and complex salt is that the aqueous solution of $\text{K}_4[\text{Fe}(\text{CN})_6]$ will not give you the tests for Fe^{2+} or CN^- ions as here a new complex ion has been formed which is ferrocyanide $[\text{Fe}(\text{CN})_6]^{4-}$ ion.

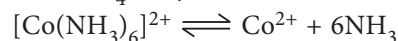
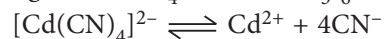
The salts in which one complex ion exists are known as complex salts or complex compounds or coordination compounds or Werner complexes.

Basically, complexes are of two types:

1. Normal or imperfect complexes

These can dissociate reversibly in the solution.

e.g., $[\text{Cd}(\text{CN})_4]^{2-}$, $[\text{Co}(\text{NH}_3)_6]^{2+}$ etc.



2. Penetration or perfect complexes

These complexes have sufficient stability and retain their identity and do not dissociate reversibly in the solution. e.g., $[\text{Fe}(\text{CN})_6]^{4-}$ etc.

WERNER'S COORDINATION THEOREM

In 1893 Werner put forward this famous theory of coordination compounds and for this he received Nobel Prize in the year 1913. He mainly worked on cobalt amines and similar compounds. His theory of complex formation is still applicable today. The main postulates of his theory are :

- (1) Every complex has a central metal atom or ion with it.
- (2) Metals have two types of valencies.
 - (a) Primary/principal/ionisable valency : It actually corresponds to the oxidation state *e.g.*, in FeCl_3 , Fe has +3 oxidation state or in $\text{K}_4[\text{Fe}(\text{CN})_6]$, Fe has +2 oxidation state.
 - (b) Secondary/auxiliary/non-ionisable valency : This corresponds to the coordination number of the metal ion. Actually, the metal atom/ion accommodates atoms, ions or groups surrounding it. These atoms or ions or groups are known as ligands and they donate electron pair to the vacant orbitals of the metal atom/ion. Number of these ions or atoms or groups is known as coordination number (C.N). The coordination number depends on the metal and also on the ligands. Werner suggested that in a coordination compound, metal and ligands should be enclosed in a square bracket. He represented $\text{CoCl}_3 \cdot 6\text{NH}_3$ as $[\text{Co}(\text{NH}_3)_6]\text{Cl}_3$. Here, $[\text{Co}(\text{NH}_3)_6]^{3+}$ is called coordination sphere.

Some common metal ions and their coordination numbers

| Metal ion | Coordination Number |
|------------------|---------------------|
| Cu^{2+} | 4 |
| Cd^{2+} | 4 |
| Fe^{3+} | 6 |
| Fe^{2+} | 6 |
| Pt^{2+} | 4 |
| Pt^{4+} | 6 |
| Co^{3+} | 6 |
| Ni^{2+} | 4 |

What you see here is that in general, coordination number is double of primary valency. For the metal ions with +4 oxidation state it goes upto 16.

- (3) Primary valency can be satisfied by either positive or negative ions whereas secondary valencies can be satisfied by either positive or negative or neutral molecules.
- (4) Primary valencies have no directional properties whereas secondary valencies have directional properties and this is the reason for which phenomena of isomerism is found in coordination compounds.
As an example you can see that in $[\text{Co}(\text{NH}_3)_6]^{3+}$, six NH_3 molecules are directed towards the six corners of a regular octahedron.
- (5) The net charge on the complex ion is the summation of the charge on the metal ion and ligands. For

example, in $[\text{Fe}(\text{CN})_6]^{4-}$, net charge is -4 because here metal ion has +2 charge and every cyanide ion has unit negative charge so, six ligand ions have 6 unit negative charge.

Now, so far it was a basic idea to introduce coordination chemistry. The main idea of this article is to present in front of you a deeper concept of the topics which frequently come in competitive examinations and often where we make more mistakes. One of these topics must be stereoisomerism in coordination compounds. Lets go with it.

Stereoisomerism in coordination compounds

Definitely, stereoisomerism arises due to the different spatial arrangements of groups (ligands) in a molecule. This is why stereoisomerism is also known as space isomerism. There are two types under stereoisomerism. They are

- (1) Geometrical isomerism
- (2) Optical isomerism

As the common coordination numbers in case of complex formation is four and six, therefore we'll discuss the stereoisomerism for square planar, tetrahedral and octahedral (square bipyramidal) complexes only. I must tell you that I started to discuss stereoisomerism just after Werner's theory because Werner's theory talked about directional property of secondary valency which leads to the concept of stereoisomerism. At first take a look to the following table :

| Coordination number | Geometry | Geometrical isomers | Optical isomers |
|---------------------|---------------|---------------------|-----------------|
| 4 | Tetrahedral | Can not be found | Very rare |
| | Square planar | Definitely found | Not possible |
| 6 | Octahedral | Definitely found | Possible |

GEOMETRICAL ISOMERISM

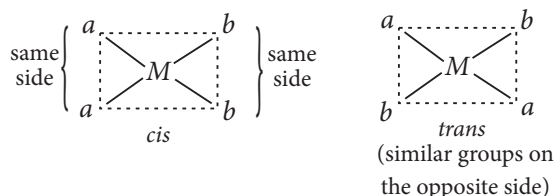
In the similar manner with the organic chemistry, geometrical isomerism is classified into two categories : *cis* and *trans*. Actually, *cis* means 'adjacent to' and *trans* means 'opposite to'. So, in the spatial arrangement when the ligands are adjacent to each other they are known as *cis* whereas when these ligands are at the farthest possible positions in space then they are termed as *trans*.

A. *Cis-trans* isomerism in coordination complexes which are square planar and have a coordination number of 4

Let us designate the metal as M and ligands as a, b, c, d etc. when and wherever necessary.

○ **Type 1: Ma_2b_2**

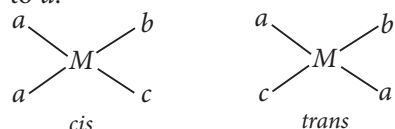
Both *cis* and *trans* isomers are found here.



e.g., $[Pt(NH_3)_2Cl_2]$

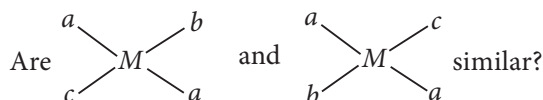
○ **Type 2: Ma_2bc**

Here, *cis-trans* isomerism is determined with respect to a .

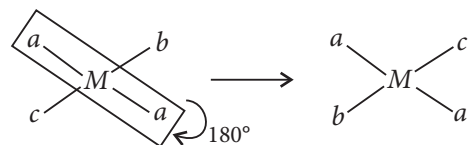


e.g., $[Pt(NH_3)_2ClBr]$

Question from students mind



(Answer) Here, along $a - M - a$ consider a plane. With respect to this plane if you rotate the structure by 180° , you can convert one structure into another.

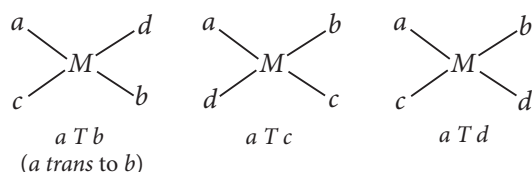


So, both the structures are spatially identical.

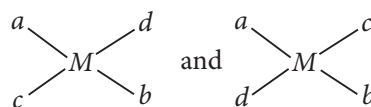
○ **Type 3: $Mabcd$**

The idea here is a bit different. At first, fix any group say ' a '. Now, you have three options :

(i) put ' b ' *trans* to ' a '. (ii) put ' c ' *trans* to ' a '. (iii) put ' d ' *trans* to ' a '. So, we have three isomers possible here.



It is needless to say that



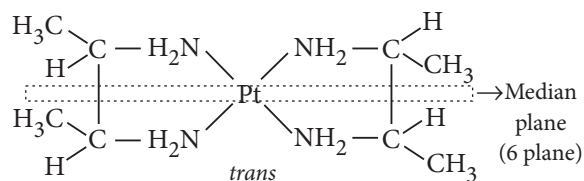
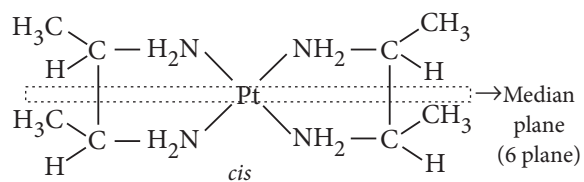
are identical and so are the other cases.

So, three isomers are possible but we do not have conventional *cis-trans* isomerism possible here.

○ **Type 4: Ma_4**

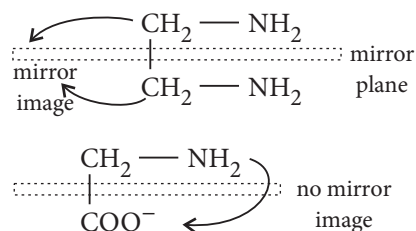
Hard to believe that Ma_4 type really shows geometrical or *cis-trans* isomerism? Here, you find the usability of this article with your conventional books.

Normally, Ma_4 type cannot show *cis-trans* isomerism but a chelate complex of the type Ma_4 with substituents on the ring atoms can often show geometrical isomerism as with respect to the median plane of the molecule *cis* and *trans* isomers are possible. Take a look into the following example.

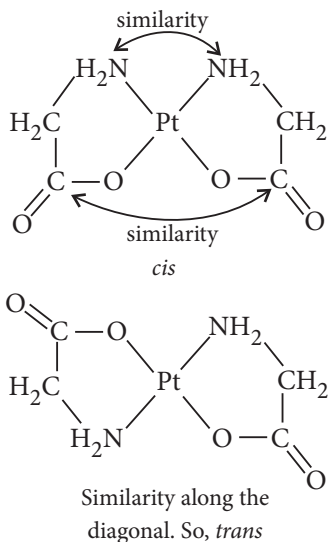


○ **Type 5: $M(ab)_2$**

Here (ab) represents unsymmetrical bidentate ligand. Actually, if a bidentate ligand can be divided into two equal halves, it is a symmetrical bidentate ligand whereas if a bidentate ligand cannot be divided into two equal halves then it is unsymmetrical bidentate ligand. For example, ethane-1,2-diamine is a symmetrical but glycinate is an unsymmetrical bidentate ligand.



So, now look at the following example.

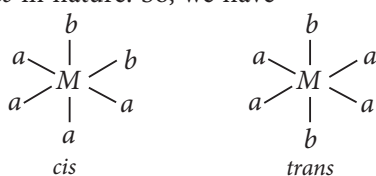


B. Cis-trans isomerism in coordination complexes having octahedral geometry and coordination number 6

Following types are obtained in this category.

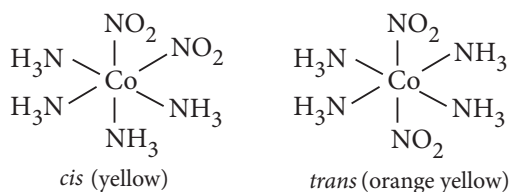
○ Type 1: Ma_4b_2

All the six positions in octahedron are equivalent. You may think about Ma_6 which can not show geometrical isomerism as all the positions in octahedron are equivalent. Now substitute two 'a' ligands by two 'b' ligands. At this time if two 'b' ligands are located edgewise then the isomer generated is *cis* isomer whereas, if two 'b' ligands occur in the axial positions then isomer obtained is *trans* in nature. So, we have



e.g., $[\text{Co}(\text{NH}_3)_4\text{Cl}_2]^+$

These isomers may even differ in their colours. For example, $[\text{Co}(\text{NH}_3)_4(\text{NO}_2)_2]\text{NO}_3$ has two isomers different in their colours. *Cis* is yellow whereas *trans* is orange yellow.



More such examples are

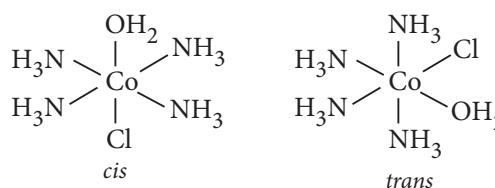
1. *cis*- $[\text{Co}(\text{NH}_3)_4\text{Cl}_2]^+$ is violet and *trans*- $[\text{Co}(\text{NH}_3)_4\text{Cl}_2]^+$ is green
2. *cis*- $[\text{CoCl}_2(\text{en})_2]\text{Cl}_2$ is purple and *trans*- $[\text{CoCl}_2(\text{en})_2]\text{Cl}_2$ is green

Remember in Ma_4b_2 type, determining factor is 'b'.

○ Type 2 : Ma_4bc

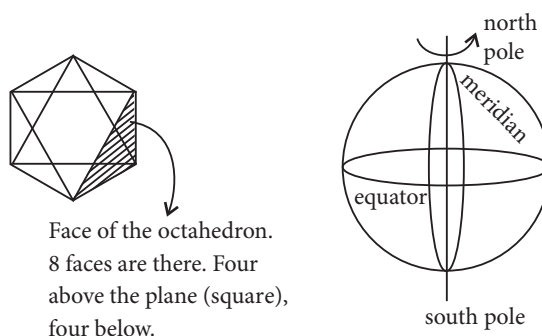
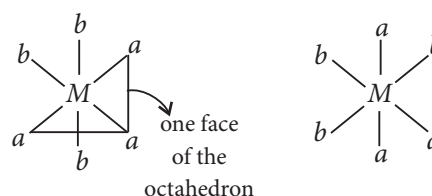
Here, determining factor will be 'a'. If all the four 'a' ligands exist in nearest positions (all the four corners of the planar square) then the isomer is *cis* and if two out of four 'a' ligands are wide apart then this isomer becomes *trans*.

e.g., $[\text{Co}(\text{NH}_3)_4(\text{H}_2\text{O})\text{Cl}]^{2+}$



○ Type 3 : Ma_3b_3

Here, we don't get conventional *cis-trans* isomerism. Rather we get facial (*cis*-type) and meridional (*trans*-type) isomer. In short facial is called as *fac*-isomer and meridional as *mer*-isomer. In case of facial isomer any three ligands of same type (either 3 a's or 3 b's) take the adjacent positions i.e. one face of the octahedron whereas in case of *mer*-isomer two similar type ligands (either two a's or two b's) occupy opposite positions to each other. Other positions are randomly occupied by the remaining ligands.

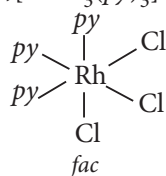


Take this idea.

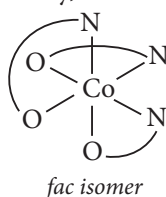
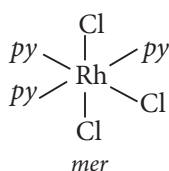
For 1, equivalent adjacent positions are 2, 3, 4, 5 as all are 90° apart (angular distance).

For 6, equivalent adjacent positions are 2, 3, 4, 5 as all are 90° apart (angular distance).

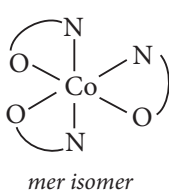
e.g., $[\text{RhCl}_3(\text{py})_3]$



Similarly,



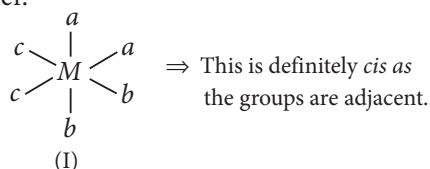
fac isomer



mer isomer

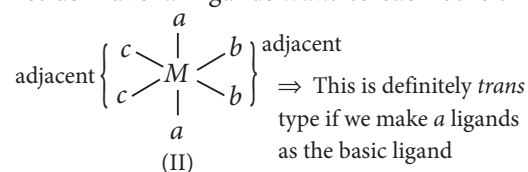
● Type 4 : $\text{Ma}_2\text{b}_2\text{c}_2$

A good amount of analysis is required here. Let us first put the similar groups adjacent to each other.

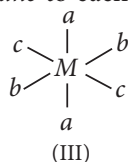


Now, let us see how many orientations are possible here.

Let us make 'a' ligands *trans* to each other.

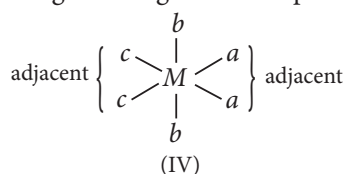


Now, from (II) another variety possible if we move similar groups *trans* to each other.



(III)

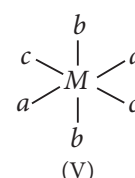
Now, let us give 'b' ligands axial positions.



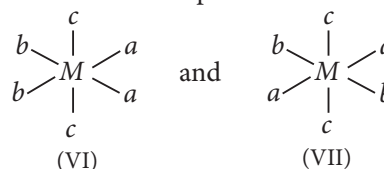
(IV)

From (IV) keeping the positions of 'b' ligands fixed, let us put both 'a's' *anti* to each other and same with 'c's'. We get

In the similar manner we should get another two isomers keeping 'c' ligands at the axial positions.



(V)



(VI)

(VII)

Now, understand a very simple thing : Structures (III), (V), and (VII) are those where all groups are *anti* or *trans* to their similar groups so, ultimately we get five isomers in total.

(I) \Rightarrow all *cis*

(II) \Rightarrow *a trans*

(IV) \Rightarrow *b trans*

(VI) \Rightarrow *c trans*

(III), (V), (VII) \Rightarrow all similar groups *trans* or all *trans*.

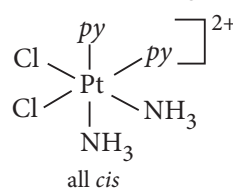
Now using a short cut trick we can make number of isomers very easily.

$\text{Ma}_2\text{b}_2\text{c}_2 \Rightarrow$ short cut trick is based on simple and basic concept of permutation and combination.

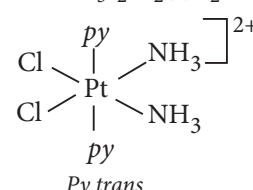
$a_2b_2c_2 \Rightarrow$

| | | |
|------|------|------|
| (aa) | (bb) | (cc) |
| (aa) | (bc) | (bc) |
| (bb) | (ac) | (ac) |
| (cc) | (ab) | (ab) |
| (ab) | (ac) | (bc) |

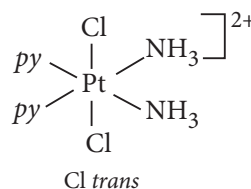
Take the following example : $[\text{Pt}(\text{NH}_3)_2\text{Cl}_2(\text{py})_2]^{2+}$



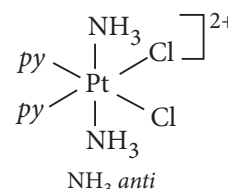
all *cis*



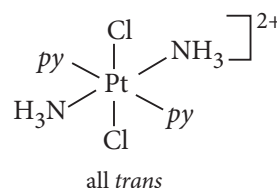
Py *trans*



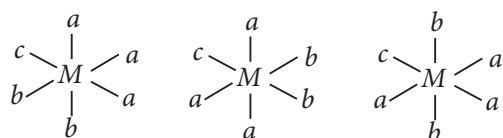
Cl *trans*



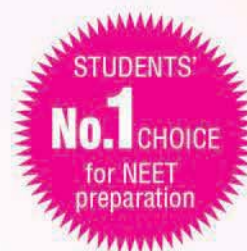
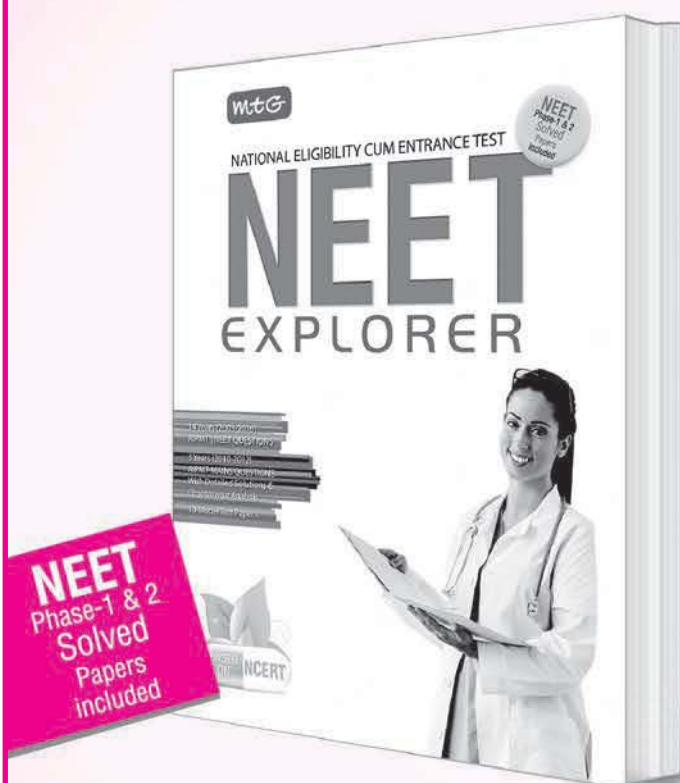
NH₃ *anti*



all *trans*

[illegible]

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ADVANCED CHEMISTRY BLOC

(THERMODYNAMICS)

Mukul C. Ray, Odisha

The insight of an irreversible process is a beautiful concept. How helplessly we fail to draw the P - V diagram? How exactly a quasi-static process differs from an irreversible process and nonetheless what is a reversible process? Read this small article to realise the things in detail.

INTRODUCTORY THERMODYNAMICS

Mechanical equilibrium is a part of equilibrium thermodynamics. In mechanical equilibrium, no unbalanced forces act on the system; hence the system undergoes no acceleration and there is no turbulence within the system.

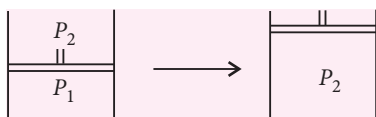
But what is equilibrium thermodynamics? Equilibrium thermodynamics deals with the system in equilibrium. An isolated system is in equilibrium when its macroscopic properties remain constant with time. A non-isolated system is in equilibrium when the following conditions are met with :

- System's macroscopic properties remain constant with time.
- Removal of system far from contact with the surroundings causes no change in the properties of the system.

If (a) holds but (b) does not the system is said to be in steady state.

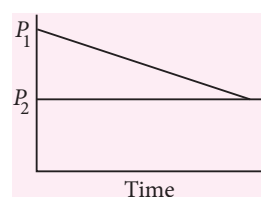
○ Turbulence in the system

Consider a gas contained in a cylinder provided with a movable piston. The gas is in high pressure and the piston is screwed. Say the piston is now released by unscrewing it.



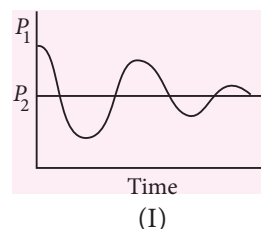
Now, how would you expect the pressure within the system to vary during the expansion? Say you are trying to plot the graph.

Is it like this? Where the internal pressure P_1 slowly drops to P_2 within the time span of expansion. Never. The expansion is never a smooth process.



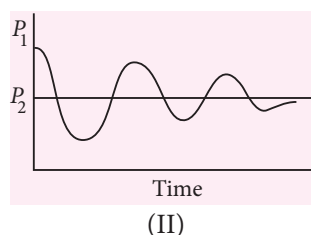
As the piston rushes upward, the pressure exactly below the surface of the piston drops. But the pressure of the gas throughout the vessel is not uniform. The gas pressure at the bottom part of the piston would rather be high. Little time is needed for diffusion to take place. As the gas diffuses from the bottom again the pressure exactly below the piston slowly builds up. Again it throws the piston.

The graph (I) rather looks like this.



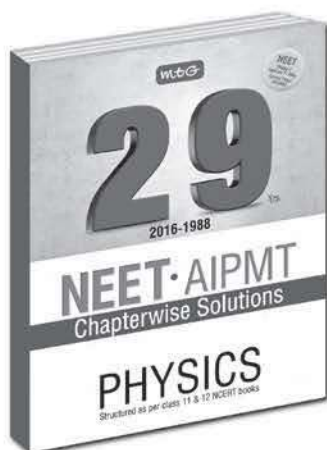
(graph of pressure just below the piston during the expansion).

But who knows this is the pattern of variation. It may be like graph (II).

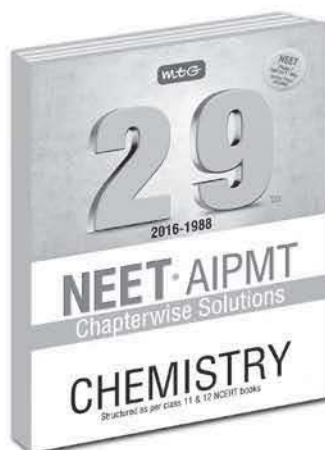


There is turbulence within the system and piston sets in acceleration. If you ask me to draw a P - V graph

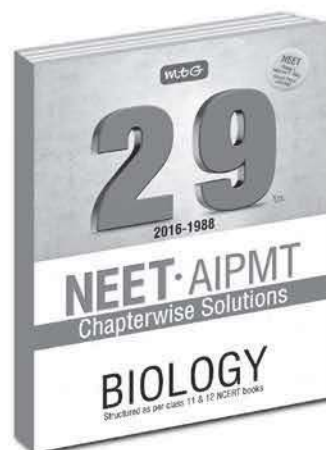
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- Chapterwise questions of last 29 years' (2016-1988) of CBSE-PMT/NEET
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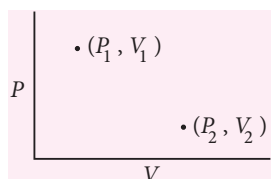
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during the expansion, how would I draw? I know nothing about the pressure of the system precisely during the expansion.

Though I know what is at the beginning and what is at the end. The best I can do is like this.

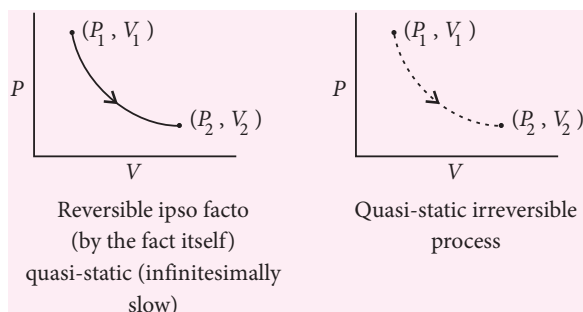


No line can be used to connect these two points. This is what, an irreversible process is.

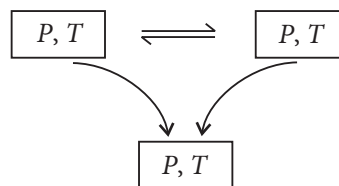
○ Reversible process

In a reversible process, therefore, as explained above, you carry out a finite process taking place in infinite number of steps spreading over infinite time.

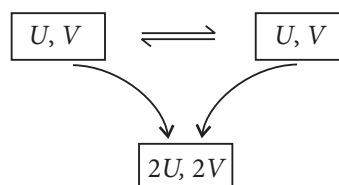
That is the reason why you say infinitesimally slowly. Besides this, some other parameters are also there in a reversible process. The piston has to be weightless and frictionless. But why frictionless? By definition the process can be reversed at any stage by an infinitesimal change in conditions. Reversal of process means restoration of both system and surroundings to their initial conditions. If your piston has friction, reversal of process would not cause all the steps to follow the opposite direction. For example, the surface of container would warm up due to friction. No matter whether it is expansion or compression. Reversible processes do not really exist. They have just been looked up like resistance less wire and frictionless pulley in physics. If a process is carried out infinitesimally slowly but has some properties of irreversible process like friction, it is called as **quasi-static process**. It can be drawn as a dotted line on a P - V diagram and can be approximated as a solid line. Remember it is an irreversible process.



Intensive variables behave as :



Extensive variables behave as :



- Extensive property is one that is additive.
- The ratio of two extensive properties is an intensive property. Mass and volume are extensive but density is intensive.
- In general, if x and y are arbitrary extensive properties.

$(x + y)$ is an extensive variable.

$\frac{x}{y}$ or $\frac{\partial x}{\partial y}$ is intensive variable.

- If x and y are intensive then

$$\left. \begin{array}{l} x + y \\ x \times y \\ \frac{x}{y} \\ \frac{\partial x}{\partial y} \end{array} \right\} \text{all are intensive}$$

Pressure, all forms of concentration, density, dipole moments, refractive index, viscosity, surface tension, molar volume, gas constant, specific heat, vapour pressure, specific gravity, dielectric constant, molar enthalpy, EMT, temperature are all intensive properties.

Volume, heat capacity, length, mass, free energy, magnetic moment, momentum, no. of moles, internal energy, entropy are all extensive properties.

MPP-5 CLASS XII ANSWER KEY

- | | | | | |
|-----------|-------------|-----------|---------|-----------|
| 1. (a) | 2. (a) | 3. (b) | 4. (b) | 5. (d) |
| 6. (a) | 7. (d) | 8. (a) | 9. (b) | 10. (d) |
| 11. (d) | 12. (b) | 13. (d) | 14. (a) | 15. (a) |
| 16. (b) | 17. (c) | 18. (d) | 19. (c) | 20. (b,c) |
| 21. (c,d) | 22. (a,c,d) | 23. (a,c) | 24. (5) | 25. (6) |
| 26. (1) | 27. (a) | 28. (b) | 29. (b) | 30. (d) |

CHEMISTRY MUSING

SOLUTION SET 39



Mole before equilibrium 1 0

Mole at equilibrium $1-\alpha$ 2α

where α is degree of dissociation = 0.503

$$K_p = \frac{(n_{\text{NO}_2})^2}{(n_{\text{N}_2\text{O}_4})} \times \left(\frac{P}{\sum n} \right)^{\Delta n} = \frac{(2\alpha)^2}{(1-\alpha)} \left[\frac{P}{1+\alpha} \right]^1$$

$$K_p = \frac{4\alpha^2 P}{1-\alpha^2} = \frac{4 \times (0.503)^2 \times 1}{1-(0.503)^2} = 1.355$$

Now, $\text{N}_2\text{O}_4 \rightleftharpoons 2\text{NO}_2$ (at pressure P)

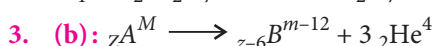
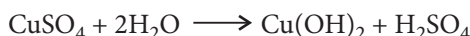
1 0
(1-x) 2x

Given, $\frac{\text{N}_2\text{O}_4}{\text{NO}_2} = \frac{1-x}{2x} = \frac{1}{8}$ ($\therefore x = \frac{8}{10} = 0.8$)

Using again at pressure P

$$\therefore K_p = \frac{4x^2 \times P}{1-x^2}$$

$$1.355 = \frac{4 \times (0.8)^2 \times p}{1-(0.8)^2} \Rightarrow p = 0.19 \text{ atm}$$



Given, Weight of A = m g

\therefore Mole of A (N_0) = 1 mole

Also, $t = 20$ days; $t_{1/2} = 10$ days

$$\therefore n = 2 \quad (\because t = t_{1/2} \times n)$$

$$\therefore \text{Amount left in 2 halves} = \frac{1}{2^2} \text{ mole} = \frac{1}{4} \text{ mole}$$

$$\therefore \text{Amount decayed in 2 halves} = 1 - \frac{1}{4} = \frac{3}{4} \text{ mole}$$

$$\therefore \text{Amount of He formed} = 3 \times \frac{3}{4} \text{ mole} = \frac{9}{4} \text{ mole}$$

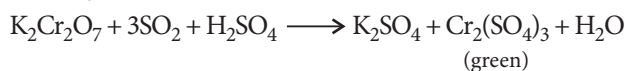
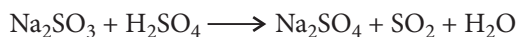
(\because decay of 1 mole gives 3 moles He)

$$\therefore \text{Volume of He at STP} = \frac{22.4 \times 9}{4} = 50.4 \text{ litre}$$



5. (c): Na_2SO_3 with dil. H_2SO_4 gives SO_2 gas which reacts with $\text{K}_2\text{Cr}_2\text{O}_7$ to give a green solution due to $\text{Cr}_2(\text{SO}_4)_3$. Since whole of the gas is consumed, the lime

water will remain clear.



6. (d): Meq. of HCl added in BaCl_2 = Meq. of NaOH

$$20 \times N = 21.4 \times \frac{1}{10} = 2.14 \quad \therefore N_{\text{HCl}} = \frac{2.14 \times 1}{10 \times 20} = 0.107$$

$$\therefore \text{Strength of HCl} = 0.107 \times 36.5 = 3.9055 \text{ g litre}^{-1}$$

$$\text{Meq. of Na}_2\text{CO}_3 \text{ added to 20 mL solution} = 50 \times \frac{1}{10} = 5$$

Meq. of Na_2CO_3 left after reaction in between



= 2 \times Meq. of H_2SO_4 using phenolphthalein indicator

$$= \frac{2 \times 10.5 \times 0.8}{10} = 1.68$$

Meq. of Na_2CO_3 used for $(\text{HCl} + \text{BaCl}_2)$ = Meq. of Na_2CO_3 consumed (added - left) = 5 - 1.68 = 3.32

$$\text{Meq. of HCl} + \text{Meq. of BaCl}_2 = 3.32$$

$$\therefore \text{Meq. of BaCl}_2 = 3.32 - \text{Meq. of HCl}$$

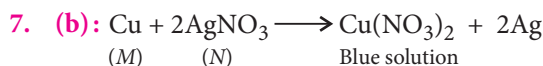
$$= 3.32 - 2.14 \text{ (Meq. of HCl} = 0.107 \times 20) = 1.18$$

$$\frac{w}{208/2} \times 1000 = 1.18$$

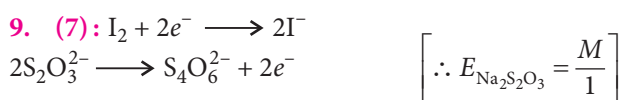
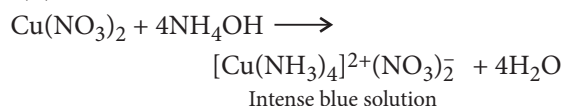
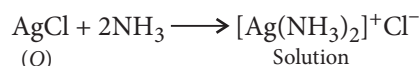
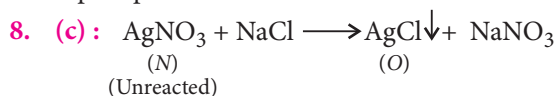
Weight of BaCl_2 in 20 mL = 0.1227 g

$$\therefore \text{Strength of BaCl}_2 = 6.135 \text{ g litre}^{-1}$$

$$\text{Sum of strength} = 3.9055 + 6.135 \Rightarrow 10.04 \text{ g litre}^{-1}$$



The unreacted AgNO_3 reacts with NaCl to give AgCl white precipitate.



Eq. of metal = Eq. of I_2 = Eq. of hypo

$$\frac{0.617}{E} = \frac{46.3 \times 0.124}{1000}$$

$$E = 107.47$$

$$107.47 = 100 + x + 0.47$$

$$x = 7$$



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- Concise theory for effective recapitulation
- NCERT based Chapterwise-Topicwise segregation of previous 10 years (2016-2007) questions of various entrance exams
- Unit tests containing level wise questions for self analysis
- 5 Mock test papers to check the readiness

CROSSWORD



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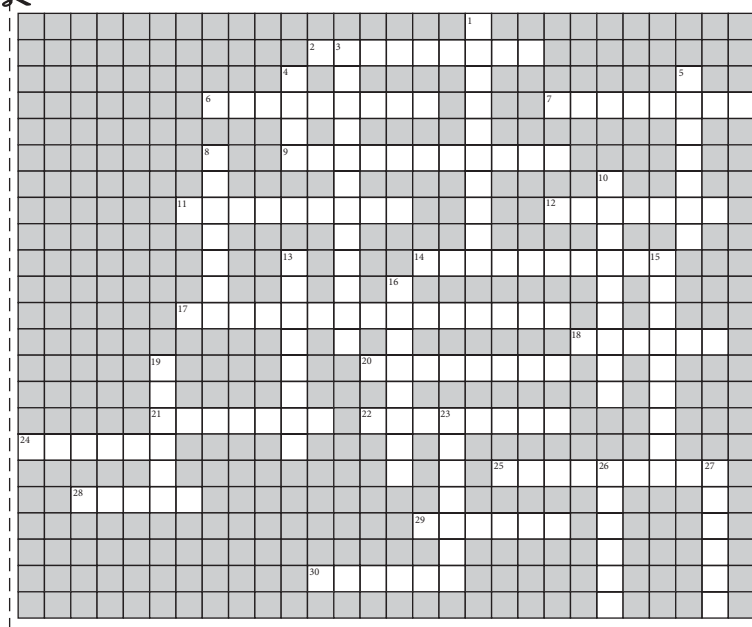
ACROSS

2. Substance which can act as an acid as well as a base. (9)
6. Mixture of two or more liquids whose proportions cannot be altered by simple distillation. (9)
7. Another name of graphite. (8)
9. Structures, with a mirror image relationship. (11)
11. Official IUPAC name of the element having atomic number 114. (9)
12. The trade name of a first soil conditioner. (7)
14. Glass having the smallest coefficient of thermal expansion. (10)
17. The process of crystallisation of a glass (a super cooled liquid) which then becomes opaque. (15)
18. Steam distillation of these gives eugenol. (6)
20. Naturally occurring impure form of alpha alumina. (8)
21. The last member of neptunium series of radioactive series. (7)
22. A monoterpene and an alcohol which occur in number of essential oils. (8)
24. A solution of definite pH; made up in such a way that the pH alters only gradually with the addition of an acid or a base. (6)
25. A term used for a solution having lower osmotic pressure/molar concentration than another solution. (9)
28. Electrode at which the negative ions are discharged during electrolysis. (5)
29. A major constituent of scot pine oil. (6)
30. Trade name of sodium hexametaphosphate. (6)

DOWN

1. A simple device for measuring the density or specific gravity of a liquid. (10)
3. Another name of hydrochloric acid. (12)
4. A point where the wave function of an atom or molecule changes its sign. (4)

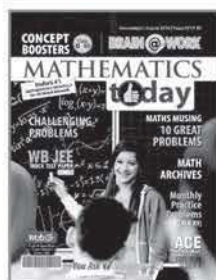
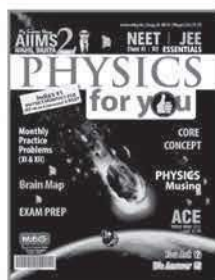
Cut Here



5. The correlation between 3J -coupling constants and dihedral torsion angles in nuclear magnetic resonance spectroscopy. (7)
8. An impure industrial sodium nitrate. (7)
10. The monocyclic sesquiterpene alcohol obtained from natural oils which is used in cosmetics. (9)
13. A thermodynamic quantity that measures the effective concentration or intensity of a particular substance in a given chemical system. (8)
15. First antimicrobial drug developed by Paul Ehrlich. (9)
16. The major constituent of the oil from orange peel. (8)
19. A molecular structure which has characteristics of two or more other structures. (6)
23. The process of replacement of an uncharged ligand in a coordination complex by an anion. (7)
26. Scientist who showed that heavy water has germicide and bactericide properties. (6)
27. The purity or fineness of gold is generally expressed in. (6)



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